THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL.

VOL. 28. Thursday, August 23rd, 1923. No. 366.

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial, 17s. 6d. per annum.
All Subscriptions are payable in advance.

All communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
BESSEMER HOUSE, 5, DUKE STREET, ADELPHI,
LONDON, W.C.2.

Contents.

	PAGE
Arc Welding of Cast-Iron now Possible	151
Novel Apprenticeship Scheme	152
American Foundrymen's Association Visit	152
Book Review	152
A Foundry Facing Development	152
Sand Conservation and Reclamation Tests Using the Doty Cohesiveness Testing Machine	153
Iron Crystals in Pig-iron	156
British Standardised Steel Samples	156
American Foundrymen's Association	157
Contracts Open	158
Pulverised Fuel Developments	158
China's Iron and Steel Industry	159
Sampling Iron and Steel	162
National Gas Exhibition	162
An Apprenticeship Course in Foundry Practice.—LV.	163
Iron and Steel Institute	165
The Shipping, Engineering and Machinery Exhibition	166
"Moulders" of the Industry.—No. 14	166
An American View on Foundry Apprenticeship	166
Common Defects in Small Important Castings	168
Trade Talk	169
Obituary	169
Correspondence	169
Foundry Queries	169
Iron and Steel Markets	170

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

Institute of British Foundrymen

PRESIDENT, 1923-24, Oliver Stubbs, M.I.Mech.E., Openshaw, Manchester.

LIST OF SECRETARIES—

General Secretary: W. G. Hollinworth, 38, Victoria Street, London, S.W.1.

Lancashire: T. Makemson, 21, Beresford Road, Gorse Hill, Stretford, Manchester.

Birmingham: H. James Roe, 33, Herbert Road, Bearwood, Birmingham.

Sheffield and District: W. A. Macdonald, 62, Bannerdale Road, Sheffield.

Scottish: W. H. Bound, 69, Minard Road, Shawlands, Glasgow.

London: V. C. Faulkner, 21, Stanley Gardens, W.11.

Newcastle-on-Tyne: H. A. J. Rang, 2, St. Nicholas Buildings, Newcastle-on-Tyne.

East Midlands: H. Bunting, 17, Marcus Street, Derby.

Coventry: J. M. Meston, 37, Melville Road.

West Ridings of Yorkshire Branch: A. Love, 232, Gladstone Street, Bradford.

Welsh Engineers' and Founders' Association.

Secretary: E. J. Griffiths, 20, Fisher Street, Swansea.

Arc Welding of Cast-Iron now Possible.

According to Mons. Lebrun, writing in a recent issue of "Revue de Metallurgie," the problem of the electric welding of cast iron was solved in France towards the end of 1920, until which time every attempt had only given a heterogeneous weld, according to the nature of the electrode employed—cast iron or steel.

When steel electrodes are used, which is the commoner method, the weld is made up of a thin layer of brittle white iron. If the weld has to be strong, it has been customary to insert steel pins on either side of the break, so as to ensure a satisfactory join. This method has been used in the United States in connection with the damaged German vessels.

Where heats have been made to carburise the steel electrode so as to transform it into cast iron by using a carbonaceous covering layer, it has been found that insufficient time can be given to allow of the necessary incorporation of the elements.

Where cast iron has been used for the electrode the carbon and silicon have been burnt out to such an extent that the welding metal consists of white iron.

According to Mr. Lebrun, the problem has been solved by using grey iron electrodes which carry a high percentage of silicon. Though, of course, both this and the added carbon burn out during the melting, there is sufficient in the original composition, and the added carbon adequately to compensate for the loss. A proper weld is established, because the cast iron remains liquid for a sufficient length of time, and during this period there is a thorough mixing taking place, due no doubt to gas expulsion. The carbon, added as either graphite or charcoal, dissolves quite easily the pool of metal, because of this "boiling" action, and the weld on cooling consists of grey iron.

Several methods come to the mind for the control of the carbon in the liquid weld metal, and probably the simplest in practice is to encase the cast-iron electrode in a mixture containing a high percentage of graphite or charcoal of suitable thickness, or the rods could be provided with a groove for this purpose. Or again they could be hollow. Similarly, carbon could be added mechanically, always bearing in mind that the quantity must be sufficient to replace that burnt out by the arc.

Mr. Lebrun illustrates his article by three micrographs which demonstrate clearly that the object sought has been attained. The graphite, however, appears to be nodular, and not of the usual striated variety. Only a small percentage of cementite is shown, which would indicate that there should be little difficulty in machining, and this observation, according to Mr. Lebrun, is borne out in practice. The grain of the deposited iron, as would be expected, is of a finer character than ordinary cast iron.

The following comparative analyses are given:—

	Ordinary C. I.	Deposited Metal.
C.C.	0.38	0.20
Gr.	2.80	2.00
Si	2.21	4.04
Mn	0.66	0.85
S	0.05	0.06
P	1.27	1.76

Neither blow holes nor hand spots have been found in the weld. The parts to be joined must, in every case, be heated to a temperature sufficient to prevent the first-deposited metal freezing too rapidly and that the carbon may have time to dissolve, otherwise the weld may contain a white zone or even undissolved deposits of carbon, both tending towards discontinuity in the weld. At least 600 deg. C. should be attained before starting.

Just how the British position stands it is difficult to say. We are aware, however, that for several years East Anglian foundries have been casting high-silicon cast-iron electrodes. How the carbon is introduced still remains unexplained

Novel Apprenticeship Scheme.

Messrs. Sydney Flavell & Company, Limited, ironfounders, of Leamington, are advertising for sixty boys, from 14 to 17 years of age, who are to be trained to become useful tradesmen.

The scheme is not intended to interfere with any present methods of schooling or technical instruction, and is solely to train moulders to make castings in the way the firm consider best.

The training does not bind the boy in any way to any Service Agreement, but it is the concern's intention in future that all skilled labour shall be drawn from this training school.

For the present each boy will be given one week's practical instruction in a foundry set apart for this purpose, alternately with one week's instruction in theory each morning, and the afternoon of this week will be devoted to athletics. Later, each boy will be required to do two weeks' practical training to one of theory.

The hours for the practical instruction week will be 7.30 a.m. to 12.30 p.m., and 1.30 p.m. to 6 p.m. Monday to Thursday, 5.30 p.m. Friday (no Saturday), with a fifteen-minute break, morning and afternoon.

The hours for the technical instruction week will be from 9 a.m. to 12.30 p.m., and for athletics 2 p.m. to 5 p.m. Monday to Friday (no Saturday). A mess room will be provided.

The weekly wages are to be as below, and a merit bonus will be paid to the boys collectively once a month, based on the amount of good work produced. Marks will be given for theoretical study, and individual prizes will be awarded monthly.

Age	1st Course.	2nd Course.	3rd Course
	s. d.	s. d.	s. d.
14—14½	5 0	6 0	7 0
14½—15	6 6	7 6	8 6
15—15½	8 0	9 0	10 0
15½—16	9 6	10 6	11 6
16—16½	11 0	12 0	13 0
16½—17	12 6	13 6	14 6
17—17½	14 0	15 0	16 0

American Foundrymen's Association Visit.

Manchester Programme of Arrangements.

Friday, August 31.—Arrive Manchester, Midland Hotel. Dinner of welcome by the National Ironfounding Employers' Federation at the Midland Hotel; reception 7 p.m. Dinner 7.30 p.m.

Saturday, September 1.—Excursions as per programme. Lecture to members of the Lancashire Branch of the Institute of British Foundrymen by Dr. Richard Moldenke, Watchung, New York, at the Manchester College of Technology, Sackville Street, Manchester, at 4 p.m. Visitors welcome.

Sunday, September 2.—Guests of the Manchester and District Ironfounders' Employers' Association. Visit to Chester. Train from Central Station, Manchester, at 9.50 a.m. Lunch at Grosvenor Hotel at 12.30 p.m. Trip on river at 2 p.m. Dinner at Grosvenor Hotel 6.30 p.m. Leave Chester 8.30 p.m. Arrive Central Station, Manchester, 10.20 p.m.

Monday, September 3.—Morning free. Afternoon: Visit to Messrs. Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester, by kind invitation of the directors. Meet at the works entrance at 2.30 p.m. Afternoon tea will be served at the works. Evening: By invitation of the President, Mr. R. A. Miles, and Council of the Lancashire Branch of the Institute of British Foundrymen, high tea will be served at the Victoria Hotel, Deansgate, Manchester, at 6.30 p.m. At 8 p.m. the visitors will leave the hotel and make their way to the Hippodrome, Oxford Street, Manchester, for the performance at 8.35 p.m.

Tuesday, September 4.—Morning free. Leave Manchester for Birmingham 2.50 p.m.

Book Review.

The Properties of Engineering Materials. By W. C. Popplewell and H. Carrington. London: Methuen & Company, Limited, 36, Essex Street, W.C.2. (Price 28s. net.)

This somewhat bulky volume is intended mainly for the use of third- and fourth-year students in the engineering schools of Universities and first-class Technical Schools. The authors hope, however, that a good deal of the earlier work can be used by second-year students also. It may also be used by students preparing for professional examinations, such as those of the Institution of Civil Engineers. There is a good deal in both parts, into which the book is divided, that may appeal to engineers in practice.

Part I. considers the relation between loads and stresses produced thereby in the more usual shapes used for structural members on the usual assumption that the material is homogeneous and truly elastic. Part II. is then devoted to a discussion of the properties peculiar to the materials themselves, with some reference in some cases to modes of manufacture; the various ways in which the materials are usually tested are also described. The behaviour of materials under repeated stress, effect of wear and deterioration, microscopic analyses, and Professor Coker's method of exhibiting stress variations with the help of polarised light also receive brief consideration.

The authors, in order to make their text-book as comprehensive as possible, have included all the principal materials used in engineering works, and consequently are unable to devote sufficient space to some of their subjects. Thus the theory of earth pressure and stability of dams are dismissed in four octavo pages of large print. Ferro-concrete beams and pillars are dealt with in a somewhat less niggardly fashion, but not to an extent commensurate with the space devoted to iron and steel structures. Beams of every kind and material are fully dealt with, but arches are completely ignored. As a matter of fact, earth pressures and the stability of dams might have been left out altogether, and then we should not have missed arches. So far as matters are dealt with, students for whom the volume is intended will find it very helpful and instructive. Examples are given at the end of each of the ten chapters in Part I. with their solutions. Here and there are also fully worked out numerical examples in the book.

A Foundry Facing Development.

A firm of Indian merchants, Messrs. J. D. Jones & Company (London), Limited, who for many years have been handling Ceylon graphite, have recently opened up a manufacturing department at 311, Burdett Road, London, E.14, with a view to supplying foundries direct. In doing so they propose to place this business on a definite chemical and physical basis, so that the consumer may know more of the graphites, plumbagoes and blackings than mere trade names. For instance, believing that the finer the graphite, the more economical its use in the foundry, they have carried out sieving tests, which gave the following results:—Six per cent. was left on an 80-mesh sieve, 8 per cent. between 80- and 100-mesh sieves, and 30 per cent. on sieves ranging between 100 and 160. It is expected that in the near future they will be in a position to furnish foundrymen with both chemical analysis and microphotographs of their brands which are to bear the following trade names:—Graphite as "No. 0," and plumbago as "Blueskyn." A steel moulder's paint is also to bear the latter appelation.

Messrs. Topham, Jones & Railton, who are closely associated with Swansea and other South Wales dock contracts, have secured the first contract for dock improvements under the Port of London Authority. The contract is for the extensions to the Surrey Commercial Docks.

Sand Conservation and Reclamation Tests Using the Doty Cohesiveness Testing Machine.*

By R. F. Harrington, W. L. MacComb and M. A. Hosmer.

A general survey of the work performed in our laboratory in connection with the problem of said conservation and reclamation, together with the application of the Doty cohesiveness testing machine,† discloses many interesting phases of the sand problem. At this time the authors do not feel that a sufficiently exhaustive study has been made of the various problems to arrive at any positive conclusions. They are confident, however, that the machine when rigidly standardised so that the results obtained in various laboratories throughout the United States may be properly compared, will be a vital factor in the solution of many of the problems encountered in the study of moulding sand.

For the interest of the trade and with the desire to stimulate discussion and further investigation the authors are enumerating the inconsistencies which their investigations have indicated. For the sake of clarity they have listed the tests in order, stating the object of the test, material used, method of procedure, data secured and results obtained. The results may be either in the nature of positive or negative deductions, or suggestions for further study and investigation.

The authors have found that when using sand of relatively small grain-size, and properly mixed to insure uniform distribution of moisture, the results obtained are very satisfactory. Not only is the percentage of variation in the weights of different sections of the same bar consistently low, but the weights of the broken sections from different bars, made from the same sand, check very well. The results from tests made on the facing sand, enumerated in Table I., will bear out the above statement.

TABLE I.—*Showing the Degree of Accuracy of Doty Test.*

Facing sand number.	Bar number.	Weight of broken sections in grams.				Average weight grams.	Per cent. maximum deviation.
1	1	191	198	193	191	193	3.6
1	2	193	196	193	189	193	3.7
2	1	190	196	191		192	3.2
2	2	195	197	192		195	2.8
3	1	178	174	179	172	176	4.1
3	2	172	167	179		173	7.2
4	1	212	222	207		213	7.2
4	2	210	217	210		212	3.4

However, when the test is applied to gravel, due to its coarser grain size, poor distribution of moisture, and presence of pellets of clay, a greater percentage of variation in the weight of various sections of the same test bar is obtained, as might be expected. This is illustrated by Table II.

TABLE II.—*Showing the Variations when Testing Gravel.*

Sample.	Test bar number.	Average weight of broken sections in grams.	Per cent. max. deviation.	Per cent. moisture content.
Gravel	1	219	12.6	5.95
Gravel	2	218	14.9	5.70
Gravel	3	222	17.2	5.41
Gravel	4	200	18.8	4.80
Gravel	5	188	17.6	7.30

Test No. 1.

Object.—To determine the effect of moisture on the cohesiveness of new sand.

Material Used.—New sand.

Procedure.—The sample for test was spread out on a concrete floor and the moisture allowed to dry out. Representative samples of this sand for determinations on moisture and cohesiveness were taken at regular intervals. In all, sixteen test bars were made and broken, the results of which are plotted in Fig. 1, using the average cohesiveness as measured in weight of broken sections in grams as ordinate and the percentage of moisture content as abscissæ.

* Abstract of a Paper presented to the Cleveland meeting of the American Foundrymen's Association.

† *Transactions A. F. A.*, vol. 30, pages 796-822.

Study of Data of Test No. 1.

A comparative study of the individual weights of broken sections from the same bar, and of similar bars, made up of the same sand, with small variations in moisture, will serve to show why we hesitate before arriving at any positive conclusion.

After calculating the averages for each test bar and plotting these values against the moisture content as shown in Fig. 1, a study of the curve obtained brings out the following points:—

1. Beginning at a maximum of 7.96 per cent. moisture and decreasing same by evaporation, we get a corresponding and fairly uniform increase in the cohesiveness of the gravel, until the moisture content has decreased to approximately 6.25 per cent.

2. Varying the moisture content from approximately 6.25 per cent. to 5.00 per cent. has but little effect on the cohesiveness of the sand.

3. The cohesiveness decreases rapidly, however, as the moisture falls below 5.00 per cent.

4. The necessity of obtaining uniform distribution of moisture throughout the heaps before taking sample for Doty test is, therefore, imperative.

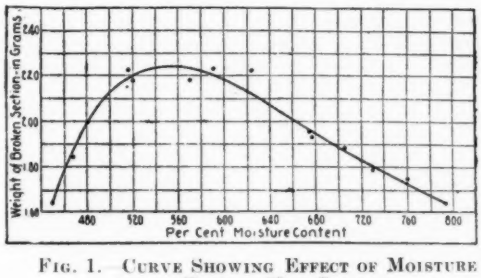


FIG. 1.—CURVE SHOWING EFFECT OF MOISTURE ON THE BOND OF NEW SAND.

5. The importance of knowing the moisture content of sands when reporting cohesiveness values for means of comparison cannot be made too emphatic.

6. That great care must be used in obtaining correct moisture in heaps.

TABLE III.

Per cent. Moisture.	Average weight of broken sections in grams. Sand dried out.	Sand dried out and remoistened
8.02		
8.02		163
7.96	164	
7.74		174
7.60	174	
7.32	179	
6.94		192
6.92		194
6.69	191	
6.66	196	
6.37		197
6.25	222	
6.13		227
5.95	219	
5.92		236
5.90	223	
5.70	218	
5.41	222	
5.20	218	
5.12	223	
5.00		257
4.84		250
4.80	200	
4.72		254
4.67		220
4.62	187	
4.47	162	
4.30		212

Test No. 2.

Object.—To determine to what extent, if any, the drying out of new sand and remoistening of the same increases its cohesiveness as compared with the same and with original moisture content.

Material Used.—New sand.

Procedure.—The sample selected for the test was divided into two portions.

Portion A.—Contained the original moisture.

Portion B.—Dried out and remoistened.

The test is a continuation of Test No. 1. Several bars from each portion with various percentages of moisture were made up and broken in the usual manner, as shown in Table III. The average value of the weights of broken sections from the individual bars were calculated, and using the cohesiveness as measured in average weight in grams of broken sections as ordinates and percentage of moisture content as abscissæ, curves were plotted similar to that of Test No. 1.

Conclusions Drawn from Test No. 2.

1. With a moisture content greater than 6 per cent., no appreciable increase in cohesiveness is obtained by drying out and remoistening the sand.

2. With moisture less than 6 per cent. an appreciable increase in strength is noted in the sand which is dried out and remoistened. At 5 per cent. moisture the increase amounts to 16 per cent.

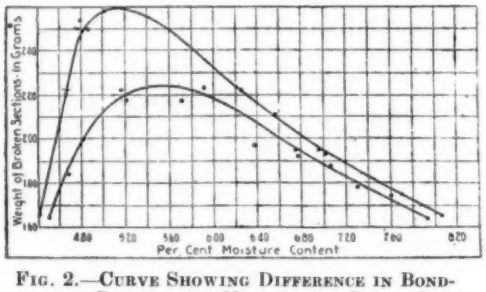


Fig. 2.—Curve Showing Difference in Bonding Strength of New Sand. Curve A is the Same as in Fig. 1. Curve B Shows the Increase of Bond Strength when the Sand is Dried Out and then Remoistened to Original Water Content.

3. Whereas we find that in the sand with original moisture content, when this moisture content varies between 5 and 6.25 per cent., there is little variation in breaking load, we note that in the sand which has been dried and remoistened there is a progressive increase until a maximum of 5.4 per cent. moisture is reached. Above this point a corresponding progressive decrease is noticed until a moisture of 4.5 per cent. is obtained. The strength of the latter at 4.7 per cent. moisture compares favourably with that of the original sand at 5.1 per cent.

4. Does the increase in strength depend entirely upon the drying out effect or is it caused by the work expended upon it in the form of hand mulling, which is necessary to distribute the moisture uniformly throughout the sand.

Test No. 3.

Object.—A study of the curves in Test No. 2 showing the difference in cohesiveness of the sand which has been dried out and remoistened as compared with the cohesiveness of the same sand, with original moisture content, clearly indicates that the sand which has been dried out and remoistened is appreciably stronger, when the moisture content is below 6 per cent. Are we justified in assuming that this increase in cohesiveness is attributed to the drying out of the sand, or are there other factors to be considered?

After the moisture was added to the air-dried sand, work in the form of hand mulling was necessary to distribute the moisture throughout the sample. Since it is generally known that mulling increases the strength of moulding sand, is it not possible that the increase in cohesiveness was due to the hand mulling which the sand received?

With the latter thought in mind, work was undertaken to determine this fact.

Material Used.—Millville gravel.

Procedure.—The sample for investigation was dried out and divided into three parts.

Part A.—With original moisture content and was not worked. Four bars were made up and broken in the usual manner.

Part B.—Similar to A except that the sand was worked by hand for a period of ten minutes, after which four test bars were broken.

Part C.—Differed from B in that this sand was thoroughly dried out, remoistened to the same moisture as that of B, and worked by hand for 10 minutes. Test bars were then broken.

All results were tabulated and averages calculated and a comparative study made as shown in Table No. IV.

Results of Test No. 3 Analysed.

It will be noted that sand B, with an average weight of broken sections of 147.45, is 6 per cent. stronger than sand A, which has an average weight of 139 grams. Also sand C, with an average of 152 grams, is 9 per cent. stronger than sand A. Now, knowing that hand mulling in Millville gravel containing 9 per cent. moisture increases its cohesiveness 6 per cent. and also that Millville gravel dried out and remoistened to 5 per cent. has a cohesiveness of 16 per cent. greater than the same gravel containing 5 per cent. original moisture, we ask if this increase in strength can be credited to the mulling action which the sand receives when the moisture is worked into the sand?

TABLE IV.

Kind of Sand.	Average Weight in grams.	General Average Weight in grams.	Average Moisture Per cent.
A	137		
A	136		
A	145	139	9
A	139		
B	148		
B	148		
B	147	147.5	9
B	147		
C	153		
C	151	152	9
C	152		

Returning again to the curve in Test No. 2, and bearing in mind that only enough work in the form of hand mulling has been done on the sand which is dried and remoistened, to mix the moisture uniformly throughout the sample, we find that with a moisture content greater than 6 per cent. the curves nearly coincide.

With this data at hand and recognising that the work done on the sand during the hand-mixing does increase its cohesiveness when the moisture content is 9 per cent., we do not feel that this increase of 16 per cent. in the dried-out and remoistened sand, over the sand with the original moisture, can be attributed entirely to the mulling action. What factor, then, is responsible for this increase in cohesiveness?

A rational physical analysis of Millville gravel shows that it is composed of the following:—

(1) Silica grains of various sizes; (2) coarse grains of feldspar; (3) clay substance; (4) transitional feldspar; (5) black particles which are probably hornblende.

Close examination reveals the presence of numerous pellets of clay. If we believe that this increase in cohesiveness in the sand which has been dried out is due to the decomposition of the clay pellets and resulting better distribution of the clay particles around the silica and grains of feldspar, why is there not a corresponding increase when the moisture content is greater than 6 per cent?

To show why this is true, we offer the following explanation. It is quite apparent that the clay substance in sand takes up water, thereby developing its plasticity with the addition of moisture, until this plasticity has reached a maximum. This maximum is attained at the same time that the clay substances ceases absorbing water, and until this point is reached, all the moisture then present in the sand is found in the clay substance.

This theory is substantiated by carefully examining a sample of sand containing a moisture of less than 6 per cent. The particles of silica and feldspar are found to be entirely free from moisture in this case, in spite of the fact that the sand appears fairly moist to the feel of the hand.

Now up to this point of 6 per cent. moisture the sand was dependent for its cohesiveness solely on clay substance, which becomes stronger in plasticity simultaneously with increase in moisture absorbed. Beyond 6 per cent. the excess water which will not be taken up by the clay substance coats the grains of silica and feldspar, and we now have not only plastic clay substance, but in addition water to bind these grains of silica and feldspar together.

Since water is not as strong a binder as clay substance, the greater the percentage of the binder that is water, the less the cohesiveness of the sand. Consequently, the excess moisture which therefore weakens the mixture takes away from the sand that property of added cohesiveness obtained in sands of lower moisture content by mulling.

When the moisture in the original sand is allowed to evaporate, the loss of moisture takes place simultaneously from the clay, silica and feldspar grains, so that there is no time when the moisture present is contained by the clay particles alone.

To illustrate, let us take two sands of equal moisture content; sand A, which has been allowed to dry out from 9 per cent. moisture, and sand B, which has been wet up from the dry state. Assuming this moisture content to be 5 per cent. in both sands, according to our previous theory sand A would have part of its moisture present in the clay substance and part covering the grains of silica and feldspar. Sand B, on the other hand, would have the entire amount of its water in the clay substance. Now, since the moisture content of the clay substance in sand B must, therefore, be more than in sand A, the latter must be the weaker sand which we have previously shown in Fig. 2 would be the case.

Test No. 4.

Object.—To determine the effect of grain size on the cohesiveness of sand. Moisture, bond and weight of sample taken were constant in each.

Material Used.—The test sand was made up of equal parts of the following:—(*a*) 1 part of fine beach sand; (*b*) 1 part of coarse beach sand; (*c*) 1 part Wareham core sand; (*d*) 1 part furnace bottom sand.

After a thorough mixing the above was dried out under the hot plate, screened and classified as follows—

Sand A.—Portion which remained on the No. 6 screen. There was not enough of this sand to run a test.

Sand B.—Portion which passed through No. 6 sieve and remained on No. 12. Not enough of this sample to make a test.

Sand C.—Portion which was retained by the No. 20 sieve.

Sand D.—Portion which remained on No. 40 sieve.

Sand E.—Portion which remained on No. 70 sieve.

Sand F.—All grains which passed through No. 70 sieve.

Procedure.—Test bars were made, keeping the amount of clay, water and sand constant. The mixtures were mulled by hand to ensure uniform mixing of the sand, clay and water and the following bars made up and broken in the usual manner. The results are shown in Table V.

TABLE V.

Sample number.	Amount of sand.	Clay in grams.	C.C. water.	Average weight of broken section in grams.
1	900 of C	350	70	222
2	900 of D	350	70	233
3	900 of E	350	70	255
4	900 of F	350	70	282

The individual results obtained are plotted with "breaking strength in grams" as ordinates and "grain size" as abscissæ in Fig. 3.

Results of Test No. 4.

The results clearly indicate that the effect of grain size in the cohesiveness of moulding sands is a vital factor. At this writing we do not feel that a sufficient number of tests have been made in this problem to warrant the establishment of any rigid relationship between the grain size and the cohesiveness. However, we are confident that we have found a very valuable application for the Doty testing machine, and hope that time may be available in the future to establish this relationship.

The fact that the test sand was made up of a mixture of four different kinds of sand is one very unfavourable feature of the test. The writers believe that better results, or at least results of greater value, would have been obtained if only one kind of sand had been selected for the original sample.

Test No. 5.

Object.—To determine to what extent machine mulling increases the cohesiveness of bushing sand as compared with the same sand mixed by hand.

To determine to what extent, if any, drying out, remoistening and machine mulling increases its strength.

Material Used.—A mixture containing 32 parts of old bushing sand and 10 parts of new sand.

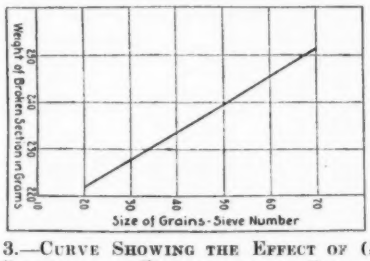


FIG. 3.—CURVE SHOWING THE EFFECT OF GRAIN SIZE ON THE COHESIVENESS OF SAND.

Method of Procedure.—Sample was well mixed by hand and divided into three portions. From each samples were taken for moisture and Doty test.

Portion A is hand-mixed.

Portion B machine mulled for two minutes.

Portion C allowed to dry out in the open, remoistened and machine mulled for two minutes.

The results of Test No. 5 are shown in Table VI.

Studying the data of Table 6 it is shown that:

(*a*) The average moisture content of sand A is 8.14 per cent., whereas sand B, which is the same in all respects excepting that it has been mulled for two minutes, gives a moisture of 7.96 per cent., or a decrease of 0.18 per cent. Since A was hand-

TABLE VI.

Kind of Sand.	Average Weight in grams.	General Average in grams.	Average Moisture Content Per cent.
A	102		
A	112	108	8.14
A	110		
B	142		
B	143		
B	147	144	7.96
B	144		
C	164		
C	164		
C	156	162	7.62
C	162		

mixed it was very difficult to secure a uniform distribution of the moisture; this fact is borne out by the results of the moisture determinations, the average figure for which was 8.14 per cent.

(*b*) An increase of 36.7 per cent. in cohesiveness of sand B over sand A.

(*c*) An increase of 48.6 per cent. in cohesiveness of sand C over sand A.

Ignoring the fact that the moisture in sand C is less than in sand B, can we assume that by drying the sand and remoistening we increase its strength by an amount equal to the difference

between 48.6 per cent. and 36.7 per cent. or 11.9 per cent. Returning to the curve No. 2 in Test No. 3 showing the effect of moisture content on the strength of our new sand and assuming that the effects of moisture in both the new sand and bushing sand are comparable, we find that with the new sand, with a moisture content of 7.96 per cent., there is a cohesiveness of 165 grams, and with moisture of 7.2 per cent. a cohesiveness of 185 grams, a difference of 7.96, less 7.12, or 0.84 per cent. in moisture between sand B and sand C, gives an increase in cohesiveness of regular sand equal to 11.9 per cent.; while the same decrease in moisture in the new sand produces a corresponding increase in strength of 12.1 per cent. Then the increase in strength of sand C over sand B is not due to the drying-out effect, but to the difference in moisture content.

Conclusions Drawn from Test No. 5.

1. Two minutes of machine mulling increases the strength of the bushing sand by approximately 36 per cent.
2. With sand with nearly 8 per cent. moisture no apparent increase in cohesiveness is obtained by drying out and remoistening.
3. An increase of cohesiveness in the same sand with the same mulling can be obtained by decreasing the moisture.

Test No. 6.

Object.—To determine if by machine mulling the bushing sand we are able to increase the effectiveness of the clay substance present as measured by the dye absorption test.

Material Used.—Regular bushing sand containing 10 parts of the new sand and 32 parts of old bushing sand.

Procedure.—The above was mixed by hand and a portion (*a*) was taken for bond determination. A second portion (*b*) was machine mulled for two minutes and sample for bond determination.

Results of Test No. 6.

Sample.	Bond.	Average Bond.
Portion A	448	416
Portion A	384	—
Portion B	512	504
Portion B	496	—

The authors regret that time was not permitted for a more extensive investigation of this phenomenon. The little work done clearly indicates that machine mulling does increase the bonding strength of the clay substance present. In this test the increase amounted to 22 per cent.

Summary of Results of All Tests.

As was stated in the introduction of this brief outline, we do not feel that a sufficiently exhaustive study of the various problems has been made at this writing to arrive at any positive conclusion; nevertheless, a careful examination of the foregoing seems to bring out certain relations which may or may not hold true at all times, but which are, nevertheless, of interest, and may serve to stimulate further study in this direction.

The salient points, therefore, are enumerated in the following general summary:—

1. The Doty method of cohesiveness testing when properly standardised is an excellent method of comparative work.
2. Moisture plays a vital part in comparing the strength of sand, and never should be omitted when reporting comparative tests by the Doty machine.
3. With a moisture content of less than 6 per cent., an appreciable difference in the strength of two sands is noticed when one is dried out and remoistened to the original percentage, while the other retains its original moisture.
4. Drying out and remoistening increases the cohesiveness of sand when the moisture content is below 6 per cent., but above 6 per cent. moisture its added strength is offset more or less by the weakness of excess moisture present.
5. All other factors being constant, the cohesiveness of moulding sand varies as the grain size.
6. Machine mulling brings out to a more or less extent the active bonding material as determined by the dye absorption test.

With the above thought left in the mind of the reader, it is hoped that this brief résumé of work thus far accomplished may contribute something in thought, or actual information of value to the extensive work now being carried on by the American Foundrymen's Association Committee on moulding sands, and to such foundries as are engaged in similar work; and that it will point out to others the vital importance of the great problem of the foundry to-day—that of sand conservation and reclamation.

Iron Crystals in Pig-Iron.

We are indebted to Mr. S. G. Smith for permission to reproduce the accompanying photograph of an iron crystal found in a pig-iron cavity. We believe the reproduction to be twice the real size of the crystal. The interest for practical foundrymen is that it illustrates the early stages

of the freezing of cast iron. Such crystals as these start growing from a series of centres, but owing to mutual interference never attain the size of the one shown; in fact, they are microscopic. Naturally, material solidifying later is found between such crystals. Our object in reproducing this photograph is to help foundrymen to realise how crystals grow in cast metals.

British Standardised Steel Samples.

The standards, which are issued jointly by the Iron and Steel Institute and the National Physical Laboratory, and which at present available are:—

No. 1.—Sulphur (S. = 0.027 per cent.).
No. 2.—Sulphur (S. = 0.071 per cent.).
No. 3.—Phosphorus (P. = 0.029 per cent.).
No. 5.—Carbon (C. = 0.65 per cent) Acid O-H Steel.
No. 6.—Carbon (C. = 0.10 per cent.) Basic O-H Steel.

These samples are supplied, post free, at 21s. per bottle containing 50 grammes, together with certificate of standardisation. They can be obtained, by sending order with remittance, direct from the National Physical Laboratory (Metallurgy Dept.), Teddington, Middlesex, or by post or personal application from: Dr. C. H. Desch, Dept. of Applied Science, The University, Sheffield; Dr. C. A. Edwards The University College, Swansea; Col. E. L. Johnson, Cleveland Technical Institute, Middlesbrough; Mr. D. A. MacCallum, West of Scotland Iron and Steel Institute, 93, Hope Street, Glasgow. Other samples are in preparation and will be issued when ready.

These samples can also be obtained from all chemists dealing regularly in laboratory supplies.

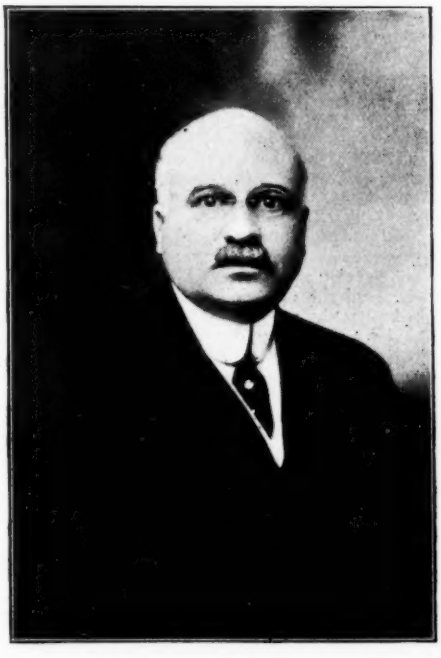
XUM

American Foundrymen's Association.

Prof. Touceda to Receive the John A. Penton Medal.

The American Foundrymen's Association has announced its first award under the John A. Penton Fund, established two years ago to provide suitable recognition of conspicuous service to the foundry industry, and a gold medal will be presented at the next Convention.

The honour was conferred upon Enrique Touceda, Consulting Metallurgical Engineer and Professor of Metallurgy at Rensselaer Polytechnic Institute, for his achievements in research and development of malleable iron.



Professor Touceda.

Prof. Touceda was born in Cuba in 1866, and received his preliminary education in private schools. He spent four years at Georgetown College, then studied at Rensselaer Polytechnic Institute, from which he graduated in 1887 with the degree of Civil Engineer. His plant experience included several years with the Troy Steel and Iron Company in various capacities, finally Chief Chemist and Metallurgist. This plant was one of the first to operate under the patents of Sir Henry Bessemer, and was built by the eminent engineer, Alexander Holley. During his experience with this and other companies, Prof. Touceda did some consulting work, and in 1898 established chemical and physical laboratories in Albany, and went into business for himself as a consulting metallurgical engineer. A few years later he was appointed to the Professorship of Metallurgy at the Rensselaer Polytechnic Institute which he still holds in conjunction with his consulting work.

In 1912 he became consulting engineer for the American Malleable Castings Association, and it is in this connection that he has done some of the work for which he is best known. At that time the quality of malleable iron produced was exceedingly irregular. While some companies had made good malleable of uniform quality, there were very few who had sufficiently close control of their processes to produce uniform metal day after day. After considerable research work in conjunction with some of the leading producers of malleable, Prof. Touceda was able to standardise the processes and analyses which gave the best results, and outline certain well-established principles which, if followed, would give a uniformity of product. The A.M.C.A., in order to provide recognition for high quality of product, established what is known as "Certified Malleable," with a certificate of quality being given only to those plants which maintained certain practices and standards of tensile strength, elongation, etc., these standards being checked under Prof. Touceda's direction by inspectors and daily test bars.

While progress was being made in uniformity, Prof. Touceda also led the movement to further improve the quality of malleable by intensive research work. The requirements of the British Admiralty are still 18 tons tensile strength and 5 per cent. elongation in 2 in., and at one time this was considered a high standard in this country. At present the requirements of Certified Malleable are that it shall have a tensile strength of not less than 22.3 tons per sq. in. and 10 per cent. elongation on 2 in., which illustrates the progress which has been made.

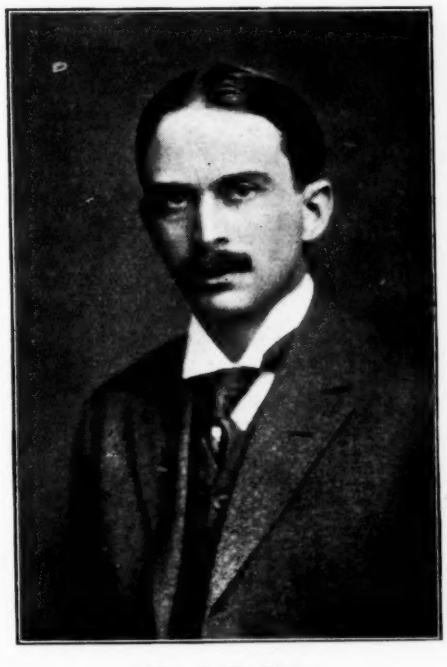
Prof. Touceda is a member of the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, Society Automotive Engineers, American Society for Testing Materials, American Iron and Steel Institute, The Iron and Steel Institute, American Society for Steel Treating, American Foundrymen's Association, American Chemical Society, and honorary member of the Institute of British Foundrymen.

His work on committees of various technical societies has been extensive and valuable. Some of the more recent include Vice-Chairman of the Iron and Steel Committee, American Institute of Mining and Metallurgical Engineers; Chairman, Malleable Iron Committee of American Foundrymen's Association and Committee on Ferrous Metals Advisory to the Bureau of Standards. Last year he delivered the exchange address for the American foundrymen at Birmingham.

The Committee on Awards conferring the medal consists of seven Past-Presidents of the American Foundrymen's Association.

Mr. J. H. Hall to Receive the J. H. Whiting Medal.

John Howe Hall, selected to be the first recipient of the J. H. Whiting medal of the American Foundrymen's Association, has been chosen because of his outstanding achievements



Mr. J. H. Hall.

in metallurgy in the steel casting industry. Mr. Hall was born June 20, 1881, at South Portsmouth, R.I., and received his earlier education in the schools of New Jersey. He was graduated from Harvard College in 1902, and received his master's degree from the Harvard Graduate School in 1903. While doing further graduate work at

Harvard he specialised in metallurgy under Professor Albert Sauveur, investigating vanadium steels. Mr. Hall then became connected with the Bethlehem Steel Company, working in various positions, finally being made assistant superintendent of their crucible steel department.

Upon leaving the Bethlehem Company in 1906 he worked for a short time with the Buffalo Crucible Casting Company, afterward going to the Taylor-Wharton Iron & Steel Company, of High Bridge, N.J., as metallographist, where, in 1911, he was placed in charge of steel making and heat treatment.

After two years in New York as a consulting engineer, Mr. Hall was employed by the Quigley Furnace & Foundry Company, of Springfield, Mass., to investigate properties of semi-steel and oxygenated iron. He then returned to the Taylor-Wharton Company, where he is at present metallurgist for this organisation's High Bridge and Easton plants.

One of his metallurgical achievements has been the development of special manganese steels and the development of a method for melting ferro-manganese for use in the manufacture of manganese steel in the cupola instead of the more expensive crucible melting method. Melting manganese steels in electric furnaces and special heat treating processes are further developments made by Mr Hall.

Mr. Hall has been very active in technical committee work, being at present secretary of A.S.T.M. Committee A-4 on Heat Treatment of Iron and Steel, and serving on this Society's committees on metallography, foundry pig-iron, and steel. He is secretary of the Iron and Steel Committee of the A.I.M.E., is a member of the A.F.A. Committee on Specifications for Steel Castings, and represents the National Research Council on the joint committee investigating the influence of phosphorus and sulphur in steel.

Mr. Hall's contributions to the publications on steel foundry practice have been very valuable and extensive, his book, "The Steel Foundry," having gone into its second edition in 1922. Mr. Hall contributed the chapters on Crucible Steel and Bessemer Steel in the well-known book, "ABC of Iron and Steel." He has presented numerous Papers at the annual meetings of the American Foundrymen's Association, Institute of Mining and Metallurgical Engineers, the Society of Chemical Industry and the American Society of Mechanical Engineers. Mr. Hall has also contributed articles on steel casting manufacture to the various technical publications devoted to the iron and steel industry.

The J. H. Whiting gold medal of the American Foundrymen's Association will be presented to Mr. Hall at the next convention of the Association.

Contracts Open.

Exmouth, August 27.—10 tons of 4-in. spigot and socket water mains, for the Urban District Council. Mr. S. Hutton, engineer and surveyor, Public Hall Chambers, Exmouth.

London, S.E., September 4.—The Director-General, India Store Department, Branch No. 14, Belvedere Road, Lambeth, S.E.1, requires (1) axles for railway carriage and wagons; (2) duplicate parts of locomotives; (3) springs, helical and volute; (4) springs, laminated; and (5) buffers, drawbar cradles and hook ends, etc.

London, S.W., September 7.—(1) Locks, etc.; (2) acid open-hearth steel boiler plates; (3) spare parts of carriages and wagons; (4) steel tyres for carriages and wagons; (5) rolled-steel disc wheels and axles for carriages and wagons (metre gauge); (6) helical and volute springs; (7) cylindrical buffers; (8) spare parts of locomotive engines; (9) steel tyres for locomotive engines and tenders; and (10) steel drawbar shackles, for the South Indian Railway Company, Limited, 91, Petty France, Westminster, S.W.1. (Fees, 2s. 6d. for Nos. 1 and 2, and 10s. for each of Nos. 3, 4, 5, 6, 7, 8, 9 and 10, non-returnable.) Robert White & Partners, consulting engineers to the company, 3, Victoria Street, Westminster, S.W.1.

Nottingham, September 14.—Supply and erection of steam, water and other pipe works, valves, tanks, etc. Preece, Cardew & Rider, 8, Queen Anne's Gate, Westminster, London, S.W.1. (Fee, £5, returnable.)

Pulverised Fuel Developments.

Mr. Baynes' Report at St. Pancras.

By David Brownlie.

Pulverised coal firing for steam generation has attracted much attention during the past three or four years in the United States. Thus, nine large boiler plants are now running in America on the "Lopulco" system, with a total heating surface of about 360,000 sq. ft., and twenty plants are at present being equipped with the same system, and will nearly all be running within the next six months, having a further heating surface of about 850,000 sq. ft. A total of over 1,200,000 sq. ft. is equivalent to something like 160 very large water-tube boilers of 50,000 lbs. evaporation per hour each, which will be a total coal consumption of about 2,750,000 tons per annum, so that pulverised fuel has certainly "arrived."

In Great Britain pulverised coal firing has so far practically only attracted attention in the Press. However, it looks as if this method of firing and the results being obtained in America, in the way of 85 per cent. continuous boiler plant efficiency, are to have their effect sooner or later in the adoption of pulverised fuel in British power stations, and in this connection the recent report of Mr. S. W. Baynes, the chief electrical engineer at St. Pancras, London, is significant. Considerable extensions are pending at the King's Road Power Station of the St. Pancras Borough Council, and the electricity committee have recommended that before these are proceeded with, a personal investigation ought to be made of some of the more prominent American power stations with a view to adopting pulverised fuel at St. Pancras, since it would be an inconvenient matter to change over to pulverised fuel later on. It may be remembered that the Union d'Electricité, who have just completed the huge Gennevilliers Station at Paris, fitted throughout with mechanical stokers, made an exhaustive investigation of pulverised fuel in America, and as a result the new Vitry Station (Paris) now under erection is being fitted throughout with "Lopulco" pulverised fuel on four Delaunay-Belleville-Ladd boilers, which will be the largest in Europe, with an overload of well over 200,000 lbs. of water from and at 212 deg. F. per hour each.

The pioneer large pulverised fuel installation is the Lakeside plant of the Milwaukee Electric Railway and Light Co. on Lake Michigan, of which 40,000 kw., was started up in December, 1920, the present section, now being doubled in size, consisting of eight "Edgemoor" boilers of 13,080 sq. ft. heating surface and working at 300 lbs. pressure in two groups of four boilers, three working and one stand-by, each group supplying a 20,000-kw. turbine. This plant is running from week to week at 85-86 per cent. efficiency. The total expenditure on auxiliary power for handling, crushing, drying and pulverising at a modern pulverised fuel plant is stated to be less than 1 per cent. of the steam production and also to involve less labour, wear and tear, depreciation, and repair costs than mechanical stoking.

As a result, some of the largest and most famous power plants in the world have adopted pulverised fuel, including, in addition to the Lakeside plant, the River Rouge plant at Detroit, belonging to the Ford Motor Company, the Ford plant in Canada, the Cleveland Electricity Company (with the largest boilers in existence, 30,600 sq. ft. heating surface), the new Cahokia Station for St. Louis, and the Trenton Channel plant of the Detroit Edison Company.

U.S. Steel Corporation and Eight-Hour Day.—On Monday, August 13, eight-hour shifts were to be introduced in the works of the United States Steel Corporation at Gary, Pittsburgh, and elsewhere. Some crews of blast-furnace workers were to be immediately changed from two to three shifts, and the new system was to be introduced throughout the whole of the Corporation's works as fast as possible without dislocating industry. Officials predict that the immediate result will be an acute labour shortage. The Youngstown Sheet Tube Company, one of the largest independent steel concerns, has announced that in changing from twelve- to eight-hour shifts the workers will be paid on a ten-hour basis.

China's Iron and Steel Industry.

By L. W. Hoyt.

Continued from page 124.

Blast Furnace of the Yangtsze Engineering Company, Hankow.

The Yangtsze Engineering Company's blast furnace is the only furnace in the Hankow district not belonging to the Han-Yeh-Ping Iron & Coal Company. It is a small stack with a rated daily output of 100 tons. The design is American (Perin & Marshall), and in every respect this furnace is quite as modern as any of the larger blast furnaces in China. The foundation work was commenced in January, 1919, and, owing to the world demand for such material as was needed in this plant's construction, a great deal of the equipment was made at the shops of the Yangtsze Engineering Company, the Chinese concern that furnished the capital for this enterprise. The furnace is supported by six cast-iron columns. There are six tuyeres, and the cooling arrangements for the bosh are as simple as possible. Just above the tuyeres is one row of copper bosh plates, but no cooling plates are used above the mantle. The upper part of the furnace is protected against hot spots by a spray to be used in case of emergency. The furnace top is the stationary double-bell type. A single-skip hoist serves the furnace, the buggy being operated by power from two horizontal hoisting engines with 12-in. high-pressure cylinders. The usual blast-furnace dust-catcher is supplemented by a centrifugal whirler for thoroughly cleaning the gas before it passes to the stoves and boilers. The skip-hoist buggy is hand-filled below, no arrangements for modern stock-house equipment having been considered necessary.

There are two horizontal compound blowing engines and one tandem compound engine. The power end of these engines was purchased in America, but the blast end was manufactured, after an Allis Chalmers design, at the local plant of the Yangtsze Engineering Works. The air from the intake is drawn through two cylindrical tanks arranged and cooled on the principle of a surface condenser.

The Yangtsze furnace was built during the period of extreme inflation, when iron was selling in China for £16 to £17 per ton. The Company owns neither coal properties nor ore mines, and it is dependent on others for raw materials. Coking coal properties (Liu Ho Kou), several hundred miles north on the Peking-Hankow line, supply the coke, and the iron comes from mines along the Yangtsze River, principally from the Hupeh mining bureau's properties near the Tayeh iron mines, only 60 miles from the furnace. The iron ore is of good quality, but the coke is very friable and high in ash.

The furnace was blown in on June 26, 1920, just at the time that iron prices in China began to crumble. From a metallurgical standpoint, the furnace acted well, the only criticism being that it is too small for efficient operation from the standpoint of costs. It is also very difficult to profitably operate a furnace that has no direct control over its raw materials, and which is at the mercy of Chinese provincial officials when it comes to the transport of coke. The political trouble in and about the Hankow district has made it impossible to operate this furnace with any degree of certainty, because the coke supply, due to political disturbances, was unreliable, and the cost of same consequently very high. In December, 1920, the actual cash costs of raw material per ton of pig were:—Iron ore, 20s. 6d.; mang. ore, 8d.; limestone, 1s. 9d.; coke, 57s.; total (say), £4. These figures, of course, do not include labour, stock-handling charges, depreciation, office expenses, nor interest. The furnace made during December, 1920, 2,446 tons of pig, so it can be readily seen that, with so small a tonnage, the overhead, etc., would add tremendously to the cost per ton. Materials and direct labour alone at that time showed a cost per ton of £4 13s. After this costs continued to rise, and prices continued to drop, so that in March, 1921, the furnace was blown out, as it could not be profitably operated. At the present time it is estimated that, all charges considered, it would cost at least £11 9s. per ton to make iron.

The Lungyen Blast Furnace.

The most recent addition to the blast furnaces of China is that of the Lungyen Mining Administration, located on the Mentakow branch of the Peking-Suiyuan Railway, about eleven miles from Peking. This furnace is the only one in the Chihli district of China, and from the standpoint of design and auxiliary equipment is undoubtedly the best in Asia, India alone excepted. It has a rated capacity of 250 tons of pig-iron per day or about 90,000 tons per year, and was designed by Porin and Marshall, engineers, of New York. In May, 1921, foundation work was started, and in July the actual work on the stack itself commenced.

The Company was originally supposed to have $5,000,000 (Mex) in its command, but only $2,500,000 was paid up. This has been absorbed in completing the plant, and, at present, while everything at the site has been paid for, there is no money left for operation. This modern, well-equipped stack could be blown in within a few weeks, if the operating capital were available.

The furnace measures 85 ft. from hearth to charging platform; is 18 ft. through the bosh and 13 ft. at the hearth. The hearth jacket is of steel-plate construction, lined with cast-iron cooling plates. The stack is supported by eight steel columns. The eight tuyères are of easy access, being offset from the columns in order to provide maximum working space. There are two iron notches, one above the other, the upper one to be used in case of emergency. The cinder notches are two in number, at the same level, and 90 deg. apart. The tuyère and bosh jackets are constructed of heavy steel plate, protected by bronze cooling plates. Above the mantle, just below the first ring of shell plates, is a line of cast-iron cooling boxes. The upper part of the lining is protected by cast-iron wearing plates built in the brick. As a result of costly experience gained at the Yangtsze furnace, American brick was used for the furnace lining proper instead of domestic brick, although the stoves are lined with Chinese firebrick. Chinese refractories do not as yet stand up under high temperature and wear, such as is encountered in blast-furnace operation.

One of the distinctive features of this furnace is the Marshall top. The four bleeder pipes rising 43 ft. above the level of the charging platform are high enough to efficiently carry excess furnace gases away from the working platform, and in addition, should trouble develop at the furnace top, can be utilised as rigging for chain blocks and tackle. The down-comers, conveying the furnace gas to the boilers and stoves for consumption, lead off from the bleeder pipes at an altitude considerably in excess of that normally considered sufficient for good practice. While it is impossible to determine, until after the furnace is blown in, just what effect this will have on the gases "going over," it is reasonable to suppose that the higher "take off" will materially reduce the dust content and send cleaner gas to the dust-catchers. This feature of blast-furnace practice in China is very important, because, despite every effort to obtain clean gas, extraneous material is carried along, due to the nature of the raw materials it is necessary to use.

The four two-pass stoves are fitted with inverted Spearman burners and are of the Marshall type. The boiler house contains five 500-h.p. vertical boilers, fitted with superheaters, delivering steam at 165 deg. superheat under 200 lbs. pressure. The power house contains two 20-in. × 30-in. engines, which drive two 350-kw. generator sets. Blast is delivered by two Ingersoll-Rand turbo-blowers.

Possibly one of the best features of the entire furnace lay-out is the very modern method employed in handling stock. The stock-house is of sturdy construction super-imposed upon a 360-ft. concrete tunnel, the roof of this tunnel being perforated at intervals by hoppers to permit the ore and stone to drop through into the scale car below. This car carries the weighed charge to the skip

pit, where it is dumped into the skip car and carried to the furnace top. An Otis elevator steam hoist operates the skip. While the limestone and ore are exposed to the weather above the tunnel, the coke stock is under cover and is stored in ample steel bins above the skip pit.

One of the most difficult engineering problems which seems to have been overcome at Lungyen is the manner in which an ample supply of clean water is assured. The Hun river is the natural source of supply, but owing to the heavy load of mud carried by this stream, it was necessary to provide a settling tank where gravity could reduce the mud content to a workable proportion. From the settling tank the cleansed water flows to a 60-million gallon reservoir located near the furnace. A half-million gallon capacity pump delivers the reservoir water to a large-sized concrete water tank near the power house. While it will be necessary for this water system to stand up under operation before it can be said to be adequate, nevertheless the experience gained through a study of the difficulties encountered by an adjoining municipal power station, certainly warrants the statement that Lungyen will be free from serious trouble in this direction.

The Lungyen Company has been granted mining rights in areas in the province of Chihli from which it is assured a large supply of iron ore of good quality. The metallic content of the ore averages about 45 per cent., and in actual operation in the furnaces at Hankow it proved itself to be on a par with the Yangtze River deposits. From a blast-furnace standpoint, no difficulty should be experienced with the ore. The deposits are at Lunghwa (Chi.) and Süanhwa, which properties are connected by rail with the Peking-Suiyuan Railway. Limestone deposits lie within seven miles of the plant, and are connected by a standard-gauge line with Sanchiatien, a town near the furnace site on the Peking-Suiyuan Railway.

No doubt Lungyen will be able to make a good grade of merchantable pig, but there is some doubt as to whether this pig can be made at a cost which will enable Lungyen to compete in Japan and other Far Eastern markets against American, European and Indian pig. This doubt is based primarily on the cost of coke delivered at the furnace. It remains to be seen whether coke can be brought to the furnace stock-house for a figure less than that quoted at Hankow, namely, £2 17s. per ton. In fact, the recent political disturbances in Hunan and the labour and mining difficulties at Pinghsiang have steadily increased the cost of coke at the Hanyang furnaces at Hankow. A recent report from the collieries of the Han Yeh Ping Co. stated that coal was costing £2 per ton delivered at the coke ovens. If this report is correct, coke will cost at least £3 per ton at the ovens, 300 miles from the furnaces. While such high costs may not be encountered at Lungyen, it is reasonably certain that, owing to disturbed conditions along the Peking-Hankow line and to the continual epidemic of labour unrest and banditry in that part of China from which the coking coal comes, coke cannot be made for less than £2 at the oven, and cannot be delivered at the furnace site for under £2 8s. per ton, lower theoretical estimates notwithstanding.

From an analysis of the coal to be used by Lungyen, it is quite certain that the coke will contain nearly 20 per cent. ash and about 10 per cent. moisture when delivered at furnace stock-house. In other words, it will take at least 3,000 lbs. of such coke to produce one ton of pig-iron using a 50 per cent. ore. Generally speaking, under Chinese blast-furnace practice, the coke cost in pig-iron is between 50 and 55 per cent. of the total cost. Figuring on 3,000 lbs. of coke, which is not considered bad practice in China, the cost of coke per ton of iron will be £3 4s. On a 50 per cent. basis, this means a total cost of £6 12s. 6d. for one ton of pig *ex* cast-house. Should this figure be approximated when Lungyen furnace is blown in, it will mean that costs at this furnace are below those of any other stack in China, Manchuria included.

In order, however, to sell the entire output of Lungyen (90,000 tons), a price at Kobé of £7 12s. 6d. must be quoted, and this price must include a reasonable profit to the company. Unless this price c.i.f. Kobé or Shanghai can be met profitably, it is doubtful whether the entire tonnage to be made at Lungyen can find a market. China has never taken much pig, and at present is taking almost nothing. The imposition of *likin* or inter-provincial taxation, as well as export duties and charges, handicaps any furnace making pig-iron in China. Adding these charges to railway and ocean freight, it is a question whether the difference in price at Kobé will be sufficient to ensure a Japanese demand.

Unless capitalists taking over the Lungyen properties are willing to put up enough money not only to operate the furnace itself, but also to build a rail mill and a bar mill with the necessary steel-mill units, it is not at all certain that Lungyen will be a financial success. Putting up $2,500,000 (Mex.) may operate the furnace, but China cannot at present consume even the pig-iron output of existing domestic furnaces, and unless rails and bars or other shapes are made by the Lungyen Mining Administration, Japan will be the sole arbiter of price as regards the Lungyen product.

A large capital will be necessary to install and operate the open-hearths and mills which will make Lungyen an independent unit, but if this capital is raised, there is little doubt that North China would take the steel products made. If possible, an arrangement should be made with the Chinese Government Railways to take the output of such a rail mill at a price based on c.i.f. Shanghai figures for imported rails. In normal times the bars would find a ready market. From experience gained at other blast-furnace plants in China, the only hope of successful operation lies in making finished steel, and even then costly supervision will not permit of any remarkably low costs.

The Anshan Iron and Steelworks, Manchuria.

The Anshan Iron and Steelworks are a subsidiary of the South Manchuria Railway, and are located at a well-selected site on this railway about 60 miles south of Mukden. The company is purely Japanese in capital and management, and was started in 1917 along very ambitious lines. Two blast furnaces were immediately contracted for, each with a rated capacity of 230 tons per day. These two furnaces were to have been but the forerunners of a scheme which, if carried out, meant the construction of a plant comprising a battery of eight blast furnaces and a steel plant and mills capable of making 1,000,000 tons of steel per year.

The first link in this ambitious chain for exploiting the iron resources of Manchuria was forged in May, 1917, when construction work started on No. 1 furnace. Simultaneously work was commenced on four batteries of coke ovens, a boiler house, power plant, stock house and the necessary auxiliary equipment for a plant of this kind. No. 2 blast-furnace construction was also started and every effort made to complete the first unit (two furnaces) of the scheme as speedily as possible, so as to take full advantage of prevailing war and post-Armistice prices for pig-iron. Just two years later, on April 29, 1919, No. 1 blast furnace was "blown in." By this time a modern town with a population of 10,000 appeared in the model city of Anshan. Millions of yen were expended in making the city worthy of Japanese enterprise, and one in every way capable of supporting a population of the size necessary for the successful operation of an iron and steel plant turning out 1,000,000 tons of steel annually.

Operation had scarcely commenced, however, when it became evident that high-grade ore in abundance was not present. The facts of the case are that, while Manchuria does contain a considerable amount of iron ore and coal, most of this ore is under 35 per cent. metallic iron and the greatest body of coal (Fushun Colliery) refuses to coke. Of the 100,000,000 tons of iron ore controlled by the Anshan Iron and Steel Company under its concession rights in the neighbourhood of the town of Anshan, only a minute portion is suitable for direct smelting in a blast furnace. The ore, which up to now has fed the furnaces, is what is known as the "secondary enrichment" ore. It has been found in pockets here and there, but in such small and uncertain quantities that commercially it has proved very unsatisfactory.

This "enriched" ore averages about 50 per cent. iron and has a hardness above 6. At the present time there is not enough of this ore left, or in sight, to supply the two blast furnaces already erected. Consequently the directors of the Anshan Company were forced to abandon their original programme and to curtail operation even on the furnaces now forming the first completed unit of the plant, namely, blast furnaces 1 and 2.

The resultant effect of this sudden realisation that the ore was of no commercial value is that the Anshan Iron and Steelworks consist of but two blast furnaces with the necessary power plant and coke ovens, and of an unproductive town some 60 miles south of Mukden on the South Manchuria Railway. As the plant stands to-day, it is a failure not only financially, but metallurgically. The blast furnaces were not properly designed, and No. 1 furnace is now being rebuilt from hearth to charging platform in an endeavour to overcome certain operation troubles that precluded successful working when the furnace was in blast. Owing to the character of the ore and the coke, it is necessary to maintain a very high temperature on the other furnace now in blast in order to operate at all. The slag volume is tremendous. When the author visited Anshan, No. 2 furnace was making only 120 tons of pig per day, and this iron averaged about 3 per cent. silicon. Such iron, of course, would be useless in an open-hearth furnace.

At present, investigations are proceeding at Anshan with a view to concentrating the ore by means of concentrating tables and by magnetic separation. A committee of American geologists has looked into this subject quite exhaustively, and while the report of the committee is not public property, nevertheless it is understood that the report prepared was favourable as to concentration. The feasibility of this concentration may not be denied, but it is a question whether or not the additional cost may not be too severe a burden for commercial success.

It is very difficult to obtain a figure as to cost per ton of pig-iron at Anshan, because there are so many extraneous items entering into costs there which are really not proper charges against operation, although, of course, they have to be met. Considering only raw material, fuel and labour expense as making up the manufacturing cost of pig-iron, we can state that it is £7 per ton. If, however, other charges, such as interest, town expense, depreciation, relining, and ore concentration are included, it is possible to put the cost per ton of product up to almost any figure, because one furnace is idle and the other is producing but 120 tons per day. With an investment of $20,000,000 gold and a production of but 45,000 tons of pig a year, it is seen that the plant is already a financial failure, and that even with a successful outcome on the question of ore concentration, it can hardly become a great producer, unless the Japanese Government or the South Manchuria Railway subsidises it liberally.

There are four batteries of by-product coke ovens —40 ovens to a battery—with a total daily output of 480 tons of coke. Tar and sulphate of ammonia are recovered. It was originally thought possible to use the coal from the Fushun Colliery near Mukden for coking purposes. This colliery belongs to the South Manchuria Railway, and operates one of the most extraordinary seams of coal in the world (1,000,000,000 tons in sight). Unfortunately, however, Anshan cannot utilise Fushun coal because it is of the non-coking variety. Anshan ovens have to resort to Penchihu coal, a fairly good coking coal mined about 120 miles from the plant and belonging to a rival Chino-Japanese concern known as the Penchihu Coal & Mining Company. There has been no difficulty in obtaining Penchihu coal in sufficient quantities, because the demand for coke at Anshan has been very limited on account of the restricted operations.

Electric Furnaces.

At present there is only one electric steel furnace in China proper. This is installed in the foundry of the Kiangnan Dock and Engineering Works at Shanghai. An electric furnace is operating in the British colony of Hongkong, but, strictly speaking, there is not to-day a single steel foundry in China—either Bessemer, open-hearth, malleable or electric.

The only city in China where an electric furnace (either ferrous or non-ferrous) could be profitably operated at the present time is Shanghai. This city has greatly increased its municipal supply of electric power, and the international settlement power house at Shanghai is as modern and efficient as any station in the world. The cost of electric power to large users of current is low. Power is delivered to cotton mills in Shanghai at less than $1\frac{1}{4}$ gold cents (0.625d.) per kilowatt-hour. The price charged for electric power at Milwaukee (the centre of the electric steel casting business in U.S.A.) averages nearer $1\frac{3}{4}$ gold cents (0.875d.).

Electricity is supplied on what is known as the "bulk" system of charging, whereby two separate and distinct charges are made. These charges are known respectively as the "capital charge" and the "running charge."

The capital charge is based upon the amount of capital which the Shanghai Electricity Department has to expend in order to meet a definite demand. This naturally varies to some extent with location of such demand in relation to the position of the municipal generating station.

The running charge is based almost entirely upon the actual cost of generating energy, and is naturally greatly influenced by the cost of fuel for the time being in force. To meet this variable factor a basic charge per kilowatt-hour is made, based upon the assumption that fuel can be purchased at a cost of 1.6 gold cents (0.8d.) per 100,000 B.T.U. In the event of this assumed cost being either greater or less than the figure given, then a proportionate increase or decrease in the basic running charge is made effective. The equity of this arrangement will be apparent when it is borne in mind that the cost of fuel is outside the control of the municipal authorities.

Foundry Practice.

The cost of power in electric-furnace practice in America usually constitutes one-third the cost of the steel in the ladle. Under conditions obtaining at Shanghai a very accurate estimate of electric hot-metal costs can be made, as nearly all materials entering into these costs have a known value in Shanghai, although none of these materials have ever been utilised in steel foundry practice there.

Let us assume that a 3-ton *acid* electric furnace is to operate in Shanghai, and that a rate of 1 1-7 gold cents (0.5715d.) per kilowatt-hour has been contracted for from the city electricity department. With this assumption the figures given below have been deduced from what are known values for the scrap alloys, refractories and labour necessary to place an electric heat in the ladle. Electrode costs cannot be quite as accurately estimated, because no electrodes have hitherto been imported into China.

6,000-lbs. *Charge* (*Figures in net tons of 2,000 lbs*).

Materials.	Price per ton.	Consumption.	Cost per heat.
	£ s.	Lbs.	£ s. d.
35%, Plate scrap	4 4	1,500	3 6 0
10%, Punchings	3 12 (local)	600	1 1 8
25%, Axle turnings	3 12 ,,	1,500	2 15 0
40%, Operating scrap	3 19	2,400	4 15 0
4%, Loss ..	0 3	240	0 6 6
Ferro-manganese	15 2	50	0 7 8
Ferro-silicon ..	14 0	25	0 3 8
Aluminium ..	77 12	5	0 4 0
Ganister	—	150	0 4 0
Silica sand ..	—	50	0 4 0
Electrodes ..	40 0	65	1 6 0
Brick	—	—	0 6 6
Ladle drying ..	—	—	1 0 0
Electricity ..	0.5715d. per kw-hr.	1,800 kw-hrs.	4 2 4
Labour	—	—	0 4 0
Laboratory expense	—	—	0 6 0
Total per heat ..	—	6.585	20 12 4
Total per net ton	—	—	6 17 6

The Chinese are excellent pattern-makers and moulders, and have been used to ironfoundry work for generations. There is every reason to sup-

pose that they would, with capable supervision, readily and efficiently grasp the details of steel-foundry operations. Electric steel can be melted in Shanghai as cheaply as in most cities of the world, and owing to this steel's freedom from oxygen it would be the kind of metal best suited to Chinese practice.

A great advantage obtaining in the Chinese market is the high price for finished steel castings. Prices for steel castings in Shanghai range from 1s. to 1s. 3d. per pound, and where emergency work is required even higher prices could be demanded by a steel foundry located there.

The Chinese Customs returns do not show steel castings as being a product of much value in imports. These Customs statistics, however, do not go into detail, and while thousands of tons of steel castings enter China each year, they are grouped for the most part under the general term "Machinery."

Sampling Iron and Steel.

By "Celsian."

Although the metallurgy and analysis of iron and steel are fully described in most books on the subject, but few of the standard authorities dwell to any extent on the sampling of the molten metal

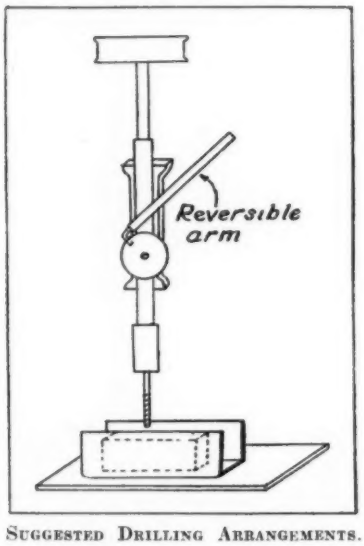
The following details deal exclusively with the sampling of iron and steel for works analysis.

With grey cast iron, the difficulties encountered in securing a representative sample are mainly due to the fact that graphitic plates abound in larger proportions in one part of the metal than another.

Steel, on the contrary, is usually reasonably homogeneous throughout the mass, and the taking of a representative sample is a comparatively simple matter.

Sampling Cupola Metal.

To test metal from the cupola, it is preferable to take several samples at intervals of, say, twenty minutes during the melting.



Suggested Drilling Arrangements.

The most suitable weight of sample to take depends on the amount of iron per charge, but should be about four pounds.

This is withdrawn from the spout with a hand ladle, poured into a sand mould, and allowed to cool under the same conditions as the castings. The ingots thus obtained are drilled through at four or five places. Boring completely through the ingot cannot be too fully emphasised, as many still adhere to the opinion that it is quite satisfactory to drill partly through both sides.

The drillings from each ingot should be analysed independently, and the mean result computed.

Where time does not permit of this, the weighings for analysis should be taken from the drillings of each ingot in equal proportion.

Mixing of borings is never satisfactory where a really accurate analysis is desired, although it is often adopted in works laboratories.

Methods such as taking out a quantity of the metal from the ladle in a small spoon, chilling in a pail of water, drilling, and analysing will never lead to accurate results as far as the percentage of combined and graphitic carbon is concerned.

As the conditions are different from those in which the iron charge was cast, the quality of the metal cannot be judged from the sample.

These samples would, of course, be quite suitable for the determinations of silicon, sulphur, and phosphorus.

This does not apply in the same way to steel, however, the condition of the carbon content being unaltered (for chemical analysis) by chilling.

Sampling Acid Steel.

Steel is usually sampled from the bath at different periods throughout the melting.

In the acid open-hearth process, a small spoonful is usually withdrawn, chilled in water and the button only drilled until about 0.5 gramme is removed, this being quite representative of the bulk.

Sampling Basic Steel.

In the basic process, a small ladleful is poured into an iron mould periodically, and the characteristics, such as the rise, sparkle, etc., closely observed.

When these have assumed the desired aspect, the red-hot ingot is transferred to a shovel, chilled in a tub of water, and about one to two grammes drilled off for rapid determinations of carbon, phosphorus, and sometimes sulphur.

Boring the Ingots.

The following modification is perhaps an advance on any of the older forms of drilling machines.

The lever which raises and lowers the drill is attached to a small reversible arm, allowing a long distance for the drill to move through without requiring readjustment of the clamp.

This saves a considerable amount of time, particularly where thick ingots have to be bored.

Where the metal is tough, and there is a danger of the ingot being inadvertently revolved, a safety measure is provided in the form of an iron slot bolted to the bed-plate. When this slot requires to be used, care must be exercised in not applying too much pressure to the lever of the drill, as the latter may stick, releasing the belting, and thus losing more time in the long run than would have been saved.

The slot is also useful for gathering the borings, which in other instances are often scattered.

In boring hot ingots, it is necessary to use drills of the best qualities of high-speed tool steel, as all ordinary varieties will readily lose their temper and become "soft-nosed."

Ingots from the furnace are seldom completely chilled, and the heat soon makes itself evident after a few minutes, if cheap drills are employed. Even with the best class of drills, it is usually necessary to re-sharpen them after boring about half-a-dozen hot samples. Fig. 1 shows the advantages of the drilling machine referred to.

National Gas Exhibition.

This Exhibition, which opens on September 17 at Bingley Hall, Birmingham, has now issued its list of exhibitors. A very large proportion of these are foundries making light castings. This factor alone will make the Exhibition of exceptional interest to foundrymen, but additionally there are many exhibits of refractories, furnaces, and high temperature measuring instruments showing, all of which cannot fail to be of definite interest for readers of this journal.

Licences, under the Non-Ferrous Metal Industry Act have been granted by the Board of Trade to:—J. R. Martin & Company, 31, Budge Row, Cannon Street, E.C.4; James Moores, 28, 30 and 32, Hayes Street, Holland Street, Manchester; Non-Oxidising Alloys, Limited, Abbey Works, Sutton Road, Erdington, Birmingham; the New Clare Smelting Works, Limited, 31, Budge Row, Cannon Street, E.C.4.

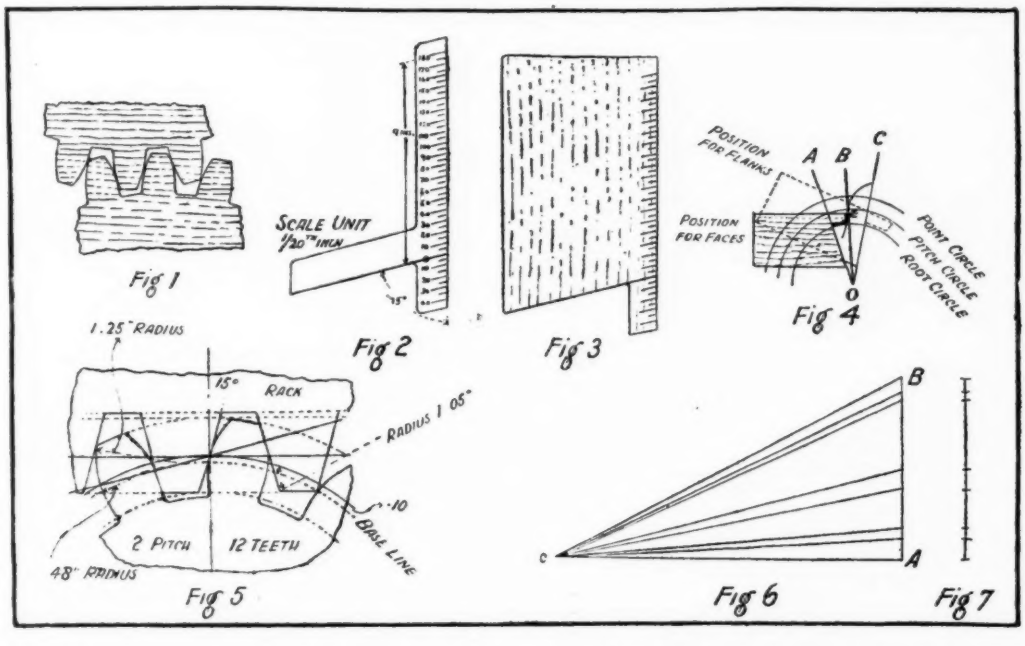
An Apprenticeship Course in Foundry Practice.—LV.

By Ben Shaw and James Edgar.

GEARING.—PART II.

Odontographs.

Odontographs are mechanical aids for designing teeth. The type of odontograph which is best known is that for designing cycloidal teeth, which was invented by Professor Willis, of Cambridge, and so close has his name become associated with the subject, that those who have not made a close study of gearing quite frequently assume that there is only one type of odontograph. As a matter of fact there are quite a few, for cycloidal and involute forms of teeth. It is very seldom that, either in drawing office or patternshop, the rolling circle *loci* for every spur-wheel is marked out geometrically. Great care and ti e are required in doing so, and a slight error will result in a bad gear. The odontograph may be termed a method of approximation, but the average craftsman will usually get as good results, often better indeed, than when he sets out either involute or cycloidal teeth geometrically.



Testing Templates.

It is always advisable to test the design with thin testing templates in mesh like Fig. 1 before making the wheels, even when an odontograph is used. If a train of seven or eight wheels are being made and the centres are accurately marked on a board and pins inserted through the templates, one template will move all the others in mesh with it easily if the design is satisfactory. When making large spiral wheels testing templates may be made at several sections in the depth of the teeth and these fitted to a framework. This forms what may be described as a skeleton of the required gear, and if it works satisfactorily the resulting castings will also work satisfactorily

Willis Odontograph.

The Willis Odontograph may be constructed of thin, hard wood, sheet brass, celluloid or cardboard, as shown at Fig. 2. Patternmakers usually adopt a rectangular shape like Fig. 3 and utilise the surface for tables, tooth proportions, and instructions as to the use of the instrument. The unit adopted in marking the scale is one-twentieth of an inch, and the angle of inclination of the arm is 75 deg. This angle is very important. The spaces are $\frac{1}{2}$ in., and each is subdivided into 10 equal parts numbered from zero on each side for flanks and faces of teeth respectively. Table I. shows the place of centres for the flanks of teeth and Table II. the centres for faces of teeth.

Fig. 4 shows the method of application of the Willis odontograph. In order to make it quite clear, let it be supposed that it is required to design the shape of a cycloidal tooth for an 18-tooth wheel of $1\frac{1}{2}$-in. pitch. The pitch diameter is obtained by multiplying the pitch by the number of teeth and dividing by 3.1416, thus: $\frac{1.5 \times 18}{3.1416} = 8$

The pitch point and root circles are set out on the drawing board, and the pitch centre lines AO and CO drawn with line of bisection BO. Referring now to Table 1, we find the number 45 in the $1\frac{1}{2}$-in. pitch column and in line with the number of teeth 18. The odontograph must now be placed along the line AO with the graduated edge intersecting the pitch line at the point of intersection of the line AO with the pitch circle. A point at 45 on the flank edge of the odontograph should be marked on the drawing board with a sharp point. This point is the centre of the radius for the flank, the radius being the distance from the centre to E. To draw the face the odontograph must now be placed alongside the line CO with the graduated edge intersecting the pitch line at the point of intersection of CA with the pitch circle. A point at 8 on the face edge of the odontograph should then be marked on the drawing board. This point is the centre of the radius for the face, the radius being the distance from the centre to E.

For drawing involute teeth one of several methods may be employed. Brown and Sharpe's method is to draw the base circle 0.968 of the diameter of the pitch circle, and the radius of the tooth curve equal to one-fourth of the radius of the pitch circle. Another method which is very satisfactory was devised by Mr. G. B. Grant and described in his treatise on "Gearing." The tooth selected as the standard for the involute form has an angle of obliquity of 15 deg., which brings the base line at about one-sixtieth of the pitch diameter from the pitch line. As the base line must always be drawn in order to save work, it is advisable to locate the centres of the approximate circular arcs upon that line. It is also necessary that the points of the teeth should be rounded over to avoid interference. To draw the wheel tooth

lay off the pitch, addendum, root and clearance lines and space the pitch line for the teeth as at tabular face radius (see Table III.) on the dividers after multiplying or dividing it as required by the

TABLE I.—*Showing the Centre-places for the Flanks of Teeth.*

PITCH OF TEETH IN INCHES (CIRCUMFERENTIAL).

Number of Teeth.	¼	⅜	½	⅝	¾	1	1¼	1½	1¾	2	2¼	2½	3	3½
13	32	48	64	80	96	129	160	193	225	257	289	321	386	450
14	17	26	35	43	52	52	97	104	121	139	156	173	202	242
15	12	18	25	31	37	49	62	74	86	99	111	123	148	173
16	10	15	20	25	30	40	50	59	69	79	89	99	119	139
17	8	13	17	21	25	34	42	50	59	67	75	84	110	117
18	7	11	15	19	22	30	37	45	52	59	67	74	89	104
19	7	10	13	17	20	27	35	40	47	54	60	67	80	94
20	6	9	12	16	19	25	31	37	43	49	56	62	74	86
22	5	8	11	14	16	22	27	33	39	43	49	54	65	76
24	5	7	10	12	15	20	25	30	35	40	45	49	59	69
26	5	7	9	11	14	18	13	27	32	37	41	46	55	64
28	4	6	9	11	13	18	22	26	30	35	40	43	52	60
30	4	6	8	10	12	17	21	25	29	33	37	41	49	58
35	4	6	8	9	11	16	19	23	26	30	34	38	45	53
40	4	5	7	9	11	15	18	21	25	28	32	35	42	49
60	3	4	6	8	9	13	15	19	22	25	28	31	37	43
80	3	4	6	7	9	12	15	17	20	23	26	28	35	41
100	3	4	6	7	8	11	14	17	20	22	25	28	34	39
150	3	4	5	7	8	11	13	16	19	21	24	27	32	38
Rack	2	4	5	6	7	10	12	15	17	20	22	25	30	35

TABLE II.—*Giving the Centres for the Faces of Teeth.*

Number of Teeth.	¼	⅜	½	⅝	¾	1	1¼	1½	1¾	2	2¼	2½	3	3½
12	1	2	2	3	4	5	6	7	9	10	11	12	15	17
15	1	2	3	3	4	5	7	8	10	11	12	14	17	19
20	2	2	3	4	5	6	8	9	11	12	14	15	18	21
30	2	3	4	4	5	7	9	10	12	14	15	18	21	25
40	2	3	4	5	6	8	9	11	13	15	17	19	23	26
60	2	3	4	5	6	8	10	12	14	16	18	20	25	29
80	2	3	4	5	6	9	11	13	15	17	19	21	26	30
100	2	3	4	5	7	9	11	13	15	18	20	22	26	31
150	2	3	5	6	7	9	11	14	16	19	21	23	27	32
Rack	2	4	5	6	7	10	12	15	17	20	22	25	31	35

TABLE III.—*For Use when Drawing Involute Teeth.*

Teeth.	Divided by the Diametral Pitch.		Multiply by the Circular Pitch.	
	Face Radius.	Flank Radius.	Face Radius.	Flank Radius.
10	2,28	.69	.73	.22
11	2.40	.83	.76	.27
12	2.51	.96	.80	.31
13	2,62	1.09	.83	.34
14	2.72	1.22	.87	.39
15	2.82	1,34	.90	.43
16	2.92	1.46	.93	.47
17	3.02	1.58	.96	.50
18	3,12	1.69	.99	.54
19	3.22	1.79	1.03	.57
20	3.32	1.89	1.06	.60
21	3.41	1.98	1.09	.63
22	3.49	2.06	1.11	.66
23	3.57	2,15	1.13	.69
24	3.64	2.24	1.16	.71
25	3.71	2.33	1.18	.74
26	3.78	2.42	1.20	.77
27	3.85	2.50	1.23	.80
28	3.92	2.59	1.25	.82
29	3.99	2.67	1.27	.85
30	4.06	2.76	1.29	.88
31	4.13	2.85	1,31	.91
32	4.20	2.93	1.34	.93
33	4.27	3.01	1.36	.96
34	4.33	3.03	1.38	.99
35	4.39	3.16	1.39	1.01
36	4.45	3.23	1.41	1.03
37—40	4.20		1.34	
41—45	4.63		1.48	
46—51	5.06		1.61	
52—60	5.74		1.83	
61—70	6.52		2.07	
71—90	7.72		2.46	
91—120	9.78		3.11	
121—180	13.38		4.26	
181—360	21.62		6.38	

Fig. 5. Draw the base line one-sixtieth of the pitch diameter inside the pitch line. Take the table, and draw in all the faces from the pitch line to the addendum line from centres on the base line. Set the dividers to the tabular flank radius and draw in all the flanks from the pitch line to the base line. Draw straight radial flanks from the base line to the root line and round them into the clearance line.

For the rack tooth draw the sides of the tooth, Fig. 5, as straight lines inclined to the line of centres at an angle of 15 deg. Some make this 14½ deg. Draw the outer half of the face one-quarter of the whole length of the tooth with a radius of 2.1 divided by the diametral pitch, or 0.67 in. multiplied by the circular pitch and from a centre on the pitch line. In some special cases, when additional strength is required, the teeth of trains of wheels that conform to the involute design have their angle of obliquity increased to 20 deg. This form gives greater strength at the root. The base line in this instance, which can be readily determined geometrically, may be calculated by taking three-hundredths of the pitch diameter measured inside the pitch circle, just as one-sixtieth is the customary practice for teeth of 15 deg. obliquity.

Grant has also prepared an odontograph table giving the suitable curves for cycloidal teeth, but the apprentice who is just starting to study the subject may be advised to adhere to one method until proficiency is attained, although he will find it instructive afterwards to compare teeth drawn by different methods. There is a method of drawing involute teeth by means of an odontograph, somewhat similar to the Willis odontograph, which dispenses with tables.

While the proportions of teeth can be accurately calculated, it is more usual to employ a scale which stands in the same relation to the method of calculation as the odontograph to rolling circles. Proportions vary slightly, and therefore not all patternmakers use the same scale. Some have a preference for a long tooth and others for a short tooth. A long tooth has more wearing surface, but it is not as strong as a short tooth. A scale of proportions is best made of hard white wood, such

as maple, plane tree, or sycamore. Instead of showing a sketch of a finished scale it may be better to explain the principle. It is sometimes stated that a scale should be 9, 12, or 15 in. long. The length of the scale, however, is of no importance. Fig. 6 represents the form which a scale takes. The height A may be divided, as shown in Fig. 7, into proportions of a 3 in., 4 in. or any other pitch. If it is divided as a 4-in. pitch, then whatever length CA is, it would be divided into four parts to give the proportions for 1-, 2-, and 3-in. pitches respectively.

Iron and Steel Institute.

Milan Meeting, September 17 and 18.

The following is the list of papers which it is expected will be submitted to the Milan meeting, to be held at the Chamber of Commerce, Milan (Via Mercanti 2-4), on Monday and Tuesday, September 17 and 18:—

(1) "Alloys in the Ternary System Iron-Chromium-Carbon," by C. R. Austin.

(2) "The Iron-Iron Carbide Equilibrium in Dry Hydrogen at 950 deg. C.," by E. D. Campbell, W. L. Fink, and J. F. Ross.

(3) "The Relative Efficiency of Dry and of Moist Hydrogen on the Decarburisation of Steel at 950 deg. C., and the effect of Hydrogen on the Phosphorus Content."

(4) "A Note on Coarse Corrugation in Mild Steel Sheets," by C. A. Edwards and L. B. Pfeil.

(5) "The Iron and Steel Industry of Italy," by G. E. Falck.

(6) "The Complex Action of Manganese and of other so-called Deoxidising Agents in the Manufacture of Steel," by F. Giolliti.

(7) "The Change Points in some Nickel-Chromium Steels," by W. T. Griffiths.

(8) "The Influence of Nickel and Chromium upon the Solubility of Steel (in relation to Corrosion)," by W. H. Hatfield.

(9) "The Iron Ore Mines of Nurra (Sardinia)," by Cesare Martelli and Tito Sotgia.

(10) "The Morphology of Pro-Eutectoid Cementite," by A. Portevin.

(11) "The Corrosion Cracking of Steel Under the Influence of Internal Stresses," by A. Portevin.

(12) "The Effect of Low Temperature Annealing on some Mechanical Properties of Cold Drawn Steels," by S. H. Rees.

(13) "Theory and Practice of Steel Refining," by H. Styri.

(14) "The Manufacture of Heavy Steel Castings from Small Converters," by C. Vanzetti.

(15) "Grain Growth in Iron and Steel," by H. C. Wang.

The Shipping, Engineering and Machinery Exhibition.

The latest bulletin issued in connection with this Exhibition, which opens on August 31, has been printed in English, French, and Spanish and circulated very largely abroad as well as at home, and shows the wide range of interests to be represented. There is a list of some forty institutions which are to pay official visits, and these functions will afford three weeks' exchange of courtesies between British manufacturers and potential customers from overseas. Foundrymen passing through London on the way to the Paris Conference should certainly arrange to spend a day at Olympia, as there are many exhibits of definite interest. One foundry firm, for instance, shows electrically-melted cast-iron castings, which show very high tensile strength. Obviously many intricate marine castings will be available for inspection. Testing, heat treatment, and temperature measurement are all features of interest to foundrymen.

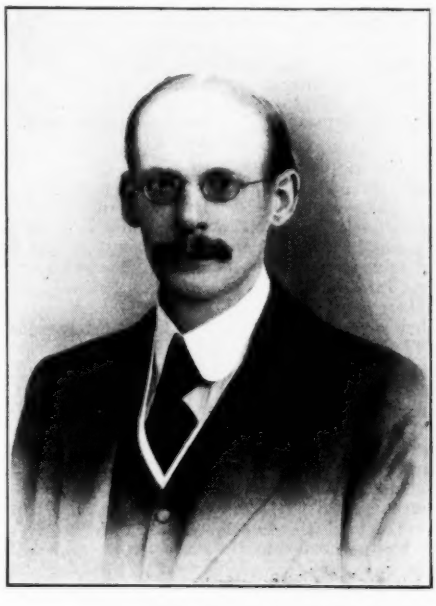
THE SHIPMENTS OF PIG-IRON from Middlesbrough (including Skinningrove) during July amounted to 8,420 tons coastwise and 27,950 tons foreign, making a total of 36,370 tons, compared with 25,829 tons in June.

"Moulders" of the Industry.—No. 14.

Professor Campion.

Mr. A. Campion was born in London, and received his general education at various schools in the city. His technical education was obtained at Finsbury Technical College, and City and Guilds Technical Institute. He acted for some time as assistant to Prof. Herbert Macleod at Royal Indian Engineering College. Mr. Campion's first industrial appointment was as chief chemist and metallurgist to Steel Company of Scotland, some four years later, in 1901, he was appointed principal assistant chemist and metallurgist to the Indian Government, at Cooper's Hill. When Cooper's Hill closed, Mr. Campion carried on a private practice in Glasgow until, in May, 1909, he succeeded to the chair of Metallurgy, in the Royal Technical College, Glasgow.

In 1918 Professor Campion became superintendent to the Foundry Technical Institute, which was instituted by the light ironfounding industry, in Falkirk, for the prosecution of foundry research, and education of foundry apprentices and workers. Trade depression led to the aban-



PROFESSOR A. CAMPION.

donment of the scheme last year, and Mr. Campion has since then been attached to the firm of Messrs. Cameron and Roberton, Kirkintilloch, and engaged in technical and research work in the foundry.

Mr. Campion has for many years been greatly interested in cast iron, and iron founding, and has carried out a large number of investigations into the properties and manufacture of cast iron and other foundry materials.

In 1902 he received a Carnegie research scholarship from the Iron and Steel Institute, and in the following year the Carnegie Gold Medal for the results of a research on the "Heat Treatment of Steel Under Works Conditions."

He is an enthusiastic member of the Institute of British Foundrymen, and it was due to his efforts that the Scottish Branch, of which he was president, 1912-1914, was founded. He also was instrumental in setting up the sub-branch in Falkirk in 1919.

He has made a special study of cupola practice and the chemistry of iron melting. The use of cast iron for internal combustion engines, semi-steel, and the heat treatment of iron and steel.

He is a Fellow of Institute of Chemistry, and member of Iron and Steel Institute, Institute of Metals, Institution of Engineers and Shipbuilders and a number of other similar societies.

An American View on Foundry Apprenticeship.*

By C. M. Morrin, Providence, R.I.

"Why is there a lack of these trained workers?" To the author's mind the reason dates back to the introduction of labour-saving machines; and to the development of the modern industrial system. These two changes in the old order of manufacture resulted in a very marked subdivision of labour, and separate operations became almost distinct vocations. The specialist, or one-operation worker, became the man of the hour, resulting in some employers discontinuing all apprentice training.

Apprentice Training Necessary.

The author holds no brief against the one-operation man, believing that he is needed in the modern system of production. But undoubtedly a serious mistake is made when apprentice training is discontinued or allowed to be sidetracked. Of the thousands of manufacturing establishments in the States, how many have apprentice training courses? Yet reports show that about one million young workers are required each year to maintain the ranks of industrial America. The Congressional commission of 1914 reported that hardly one per cent. of fourteen and a quarter million workers was adequately trained.

Conditions Responsible for Present Lack of Apprentice Training.

Is the employer alone to blame for this condition? By all means, no; for the labour organisations have and are fostering the spirit that the number of trained journeymen should be restricted. Why should a labour organisation attempt to withhold education for workers?" One reason that seems to stand out is that with a limited number of these journeymen, wages would necessarily be higher for that particular trade, so that employers would outbid each other for the limited number of trained men. It has been said that in the city of Chicago a short time ago there was not one apprentice plasterer. The average age of those in the Plasterers' Union was between 40 and 45 years. This is an extreme illustration of what restricted apprenticeship can do.

School systems, too, should share some responsibility for this lack of trained workers. Boys have received the impression that theory was all that was necessary to make a success; and manual labour was, to a certain extent, frowned upon. Steps are being taken to remedy this condition through the trade schools and co-operative courses; and manual training in the schools is a benefit; but does not, and cannot, supplant real apprentice training in the shops. Parents are often responsible for preventing boys from entering manual trades by using their influence against it—the belief of the parents being that the boys could do better, to use a shop term, "at a collar and tie job"—in other words, that a start from the office would be better than from the production department. Possibly the parent oftentimes thinks this from the fact that he himself has made only a partial success because he was not trained; and fails to see the advantages and opportunities for advancement resulting from proper training. These are some of the anomalies of the situation. The next question is, "What can be done?"

What Should be Done to Attract Apprentices.

One of the first things to do is to make the foundry and factory as attractive as possible to the boys in its physical conditions. We should work in close co-operation with the schools; and place before the education authority and pupils the possibilities for training and advancement in the plants. In fact, we should place before the general public industrial training in its true light. In other words, employers should plan an active campaign for industrial training. We should institute a campaign for safety; and for the moral upbuilding of all the employés, for the better our factory and foundry conditions are, the better the grade of workers we can secure.

What has active safety work to do with apprentices? It is indispensible, for the less hazardous we make the foundry, and more attention is paid to safety, the more care will be taken, and the easier it will be to interest the boys. The same holds good of orderliness. Well ventilated, orderly foundries make a far more favourable impression, being more conducive to good work and good health, than those of the old order. Adequate facilities for the employes' cleanliness is a condition that affects not only the employes, but those outside the plant will be favourably impressed with the appearance of the employes as they go and come; and the quality of the work may be judged accordingly.

Give a boy an opportunity to learn English if he is not English-speaking. Encourage him to become a citizen, and give him a chance to learn something of the government of the country. Encourage him to save by means of saving plans, insurance, etc. Shop gardens, wherever possible, have a good influence. These are but a few of the ways in which conditions can be improved; and the lack of these conditions has been the cause of creating the impression that the foundry should be the last place to look for work.

Granted that the conditions in the foundry are good, and that there is an opportunity to secure apprentices, what does the apprenticeship mean? The dictionary says, "one who is bound by indenture to serve some individual or company for a specified time in order to learn some art, trade, profession, manufacture, etc., in which the master or masters become bound to instruct him." That is all very well as far as it goes; and there would be a great improvement over present conditions if even that were lived up to; but the management should not only be bound to instruct him, but should take an active interest in the apprentice. He should mean more to the employer than just a boy who is to be a cheap hand. The employer should see to it that the purpose of the training in his factory or foundry is to make a skilled worker; for the management should train the boy to be skilled with his hands primarily; and not attempt to train for leadership if it must be done at the expense of workmanship. By this it is not meant that any recommendation to work a man into a narrow groove from which there is no escape is implied. But it is the author's belief that skill will develop only by actually doing the various operations, and that repetition makes for skill. Training for leadership is something inherent in the man, and will develop as a man becomes experienced, and that leaders will stand out and grow to their proper station.

Apprentice Courses Should be Well Organised.

Apprentice training is not new at the Brown & Sharpe Manufacturing Company's plant, where it has been a policy to take apprentices during the last 70 years. Here the courses include machinists, moulders, coremakers, blacksmiths, patternmakers, and draughtsmen. There is what is termed the apprentice department; that is, the boys, although working in the various production departments, are controlled under one head. A schedule is laid out for each boy and the apprentice department is responsible for his movements from one department or job to another so as to maintain that schedule. This gives a more uniform training and relieves the production foreman of the responsibility of the boys' training in other departments than his own. But it is not meant that the foremen should be allowed to lose interest in the apprentices. There should be full co-operation between the production foremen and the apprentice department.

How the Management Keeps in Touch with the Apprentices.

In addition to the instruction received from the foremen on the various jobs, there is a shop

* An abstract of a Paper presented to the Cleveland meeting of the A.F.A.

instructor who visits the boys regularly, giving them advice and instruction about their work. With the regular shop work there is combined a school course in which elementary arithmetic and applied mechanics are taught, not as academic subjects, but as shop problems, the boys seeming to grasp the ideas better by using applied problems. This school work is correlated as far as it is feasible with shop work.

In order that the management may keep a personal interest in, and an acquaintance with the boys, and to have the boys feel that an interest is taken in them, and that they have a chance to bring their particular desires to the attention of those who are in authority, there is a formal system of interviews at stated intervals during the apprenticeship. The boys are interviewed by the apprentice supervisor, the head of the employment department, the works superintendent, the sales manager and the industrial superintendent, almost all of whom are themselves former apprentices. It is proving helpful, and gives an opportunity to draw out the boys and get their reactions from different angles; and gives the heads of the departments a chance of meeting and choosing boys who should prove to be good material.

Advantages of a Trial Period.

The fact that there is a trial period before definitely taking on a boy works to advantage both to the firm and to the boy, as it eliminates boys that would be unfit or dissatisfied. This period is for three months, in each of the trades; and if a boy is definitely accepted for apprenticeship, this trial time is included as part of his total time. The firm enters into a formal agreement, and requires a sum of money to be paid for learning the trades, our reason being that by this method more serious attention is given by both the boy and his parents, and it has a tendency to eliminate the half-hearted applicant. If conditions are such that the entrance fee cannot be paid outright, the company arrange for a part-payment plan, or they deduct a certain amount from the boy's weekly pay.

To quote from the concern's booklet, "Apprenticeship," the problem of apprentices is completely to educate young men in their chosen trade so that they can qualify with us or elsewhere in the machine industry as highly skilled workmen, and as leaders of those who have not had the advantages of a general training. It is their intention to take only boys who have a sincere desire to learn a trade; and to keep out those who just want a job. A chance applicant from the street, it has been found, is not as a rule good material. By bringing the apprenticeship before schools and organisations that would be interested in industrial education, it is possible to secure boys who are really interested and have the ambition necessary to succeed.

Foundry Apprenticeship.

For foundry apprentices the firm try to get boys between 17 and 20 years of age who are of rugged build and without physical handicaps. They must have a secondary school education or its equivalent, and must pass an entrance examination at the firm's school. This examination covers simple arithmetic and such subjects as boys from secondary school should know. If an applicant lives at a distance from our works, arrangements are made with some responsible person in the boys' locality to give him the examination and return it to the firm. Before the boy begins work he is given a physical examination at the company's dispensary, and the physician's report of this examination is kept on file with the boy's records.

During the three months' trial period the boy acts as a moulder's labourer, and also is given certain routine operations that it may be ascertained whether he is fitted for the work or not. During this trial period reports are filed by his foremen, shop instructors, and class instructor covering industry, deportment, workmanship, and mechanical judgment. These reports are made on a printed form, and a uniform method of marking is used so that the marks can be averaged to give the boy's rating. If the boy rates a passing mark at the end of his trial period, the firm arrange to have both him and his parent sign a formal agreement and pay the £5 fee required for learning. This agreement is for a three-year apprenticeship, divided into three periods of 2,455 hours each. The time served during the trial period is included in this three-year contract.

The Wage Rate.

The wage rates increase at the beginning of each period. If, however, a boy receives an excellent rating in both shop and school, he receives an hourly bonus as long as he holds this excellent rating. Each six months constitutes what we call a term; and the boy's marks are averaged and a report of his progress is sent to his parents or guardian. His school work is carried on during working hours, and the boy is paid for his time. He must spend a definite number of hours at school each week and is expected to turn in a certain amount of work. This work covers arithmetic, foundry problems, and drawing as applied to foundry problems.

The First Year's Work.

The whole of the first year is spent in what is termed the heavy foundry. Work in this particular section is more general in character, and the boy receives a broader training than he would in the light foundry. For the first four months, including his trial period, he acts as a helper to one of the moulders. Then as the boy develops, he is placed on what is termed the side floor, and is given work to be carried on on his own initiative, of course, under the supervision of the foreman and instructor. After a time on the side floor, he is transferred to the heavy or crane work, where he works under a journeyman who assigns work to him that gives him a general training.

The Second Year.

The first three months of the second year are given over to coremaking. Here again the boy is put under the direct supervision of a journeyman coremaker, and works somewhat in the nature of a helper. After finishing this work he goes to our light core room, where he is put on work that he can carry through by himself. For the remaining nine months of his second year he again returns to the foundry where his work is carried on by himself. This work is of a more general character, and is given with a thought of creating self-confidence and to develop his reasoning power.

The Third Year.

The first three months of the boy's third and last year are spent in the light foundry on the bench, usually beside a moulder who is picked out for his thorough workmanship and ability to handle boys. He receives instruction from this journeyman as well as from the foreman. The next two months he spends on moulding machines, going through the regular routine work of these machines. He again returns to the heavy foundry, and is expected to carry on work of a light character entirely on his own initiative under the supervision of the foreman. After five months of this heavy foundry work, he goes to the cupola for a month, where he is taught charging, pouring mixtures, and work of a like nature in connection with the cupola. The boy's last month is spent in the heavy foundry work of a general character, with the thought of bringing him along into work that would be suitable for him after his time is completed.

Apprenticeship for Coremakers.

The coremaker apprenticeship covers a period of 1½ years, divided into periods of six months each. Of the first twelve weeks, or trial period, half the time is spent in the light core department on bench work, and half the time in the heavy core department on floor work. The remaining twelve weeks, if the boy has proved satisfactory, is spent in the heavy core department.

The second six months is spent entirely in the light core department. The last six months the boy is returned to the heavy core department and finishes his time there. As in our other courses, the coremaker has a school course of his own, and must attend school at stated periods. He also receives instruction by means of lectures.

Conclusions.

In conclusion, it should be stated that the scheme outlined is the only one system; neither do we

say that any one system can be universally used. But we do believe that one must have some sort of a definite system to make a successful apprentice course. We believe that if the responsibility for training the boys is not centralised, and if one resorts to a haphazard method of moving the boys from job to job, the aim will not be accomplished. Neither will an apprentice system be successful without full co-operation from the heads of the plant to the under-foremen and charge hands.

We believe that better results would be obtained if there were closer co-operation between schools and factories; but it is not thought that school courses, whether manual training or trade schools, can supplant apprentice training in the schools or factories. We believe under the above conditions a formal agreement works to advantage both to the employer and to the employe; and we believe that a foundry apprenticeship, to be successful, should cover all branches of foundry work.

Common Defects in Small Important Castings.

By S. G. Smith, M.I.Brit.F.

(*Continued from page* 120.)

Valve Wheel.

Fig. 4 illustrates a valve wheel, and is a type of casting which must be free from blemishes. The deep thread shown in Sketch A when machined must have a definitely smooth finished surface, and the centre, when bored, must be quite clean and sound. The use to which this wheel is put necessitates a clean casting, as even the hand-wheel part of it is polished.

From Sketch A (Fig. 4) it will be seen that the diameter of the bore is given as 2 in. and 1 in., these figures being approximate as various sizes are made, but the chief defects are common to all. Formerly the core was cast in, with, of course, a machining allowance, but as long as this was continued the percentage of scrap was very high. The defects were chiefly associated with dirt, which was trapped in the casting, either on the inside or the outside. This was due to several causes for which the presence of the core was chiefly responsible. Being of opinion that the removal of the core would mean the disappearance of the defects, the author caused the castings to be made solid. The threaded boss or stalk was lengthened, and a feeding riser placed permanently on top as shown in Sketch B (Fig. 4). The results proved entirely satisfactory.

With this design of valve-wheel it has been noted that the heavy boss has been the cause of fracturing the arms, as is shown in Sketch A, Fig. 4. This is brought about by the boss continuing to contract a considerable time after the rim, hence the "pull" at the arms. It is often impossible to alter the design of this kind of wheel sufficient to minimise the tendency to fracture. The best remedy is to strengthen the arms so as to make the cooling more uniform. Additionally, the rim and arms should remain covered with sand until the casting is cold; and also, when convenient, the boss should be bared, which will materially equalise cooling.

Valve Stem Bush.

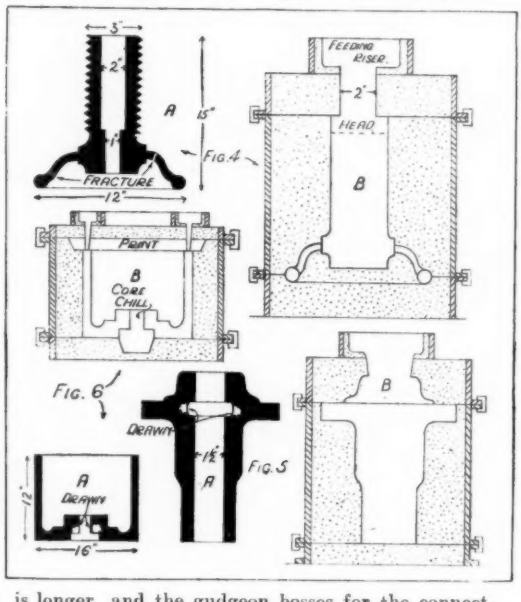
The exacting duties demanded from an exhaust valve stem-bush, shown in Fig. 5, requires that the casting should be perfectly sound and clean. In Sketch A, Fig. 5, the drawn and porous places are clearly indicated. A straight core was previously cast in and afterwards bored out as shown. It was during the operation of boring out the recess that the porous places were brought to light. An examination of the section of the metal at this position reveals that drawn places were to be expected, especially as adequate feeding was impossible. In the opinion of the writer, this was another instance that if the centre core be left out the defects would soon disappear, hence, as shown in Sketch B, Fig. 5, it was cast solid with a large feeding riser.

It must be clearly understood that in all of the last three cases (Figs. 3, 4 and 5) to ensure soundness, feeding by rods would be necessary. It should be stated that in all cases before resorting to the omission of cores other methods were tried and rejected, and in every case the extra cost entailed in the machine-shop operations was a mere trifle compared with the reduced percentage of wasters both in the machine shop and the foundry. Eventually these benefits were recognised by all concerned.

A Piston Trouble.

Fig. 6 is one of a large variety of pistons. It is one of the simplest design, and is called the upper or top piston that forms part in the line of a vertical gas engine stroke.

The only trouble experienced when making this design of piston (apart, of course, from a spotless casting) is the porous places shown in sketch A, Fig. 6. This bottle-neck hole is required for coupling together the bottom or lower piston, which is accomplished by means of a nickel steel bolt passing through a cast-iron sleeve which serves as a distance piece. The upper cylinder-head is fixed above this piston, and an intermediate cylinder head comes between the upper and lower pistons. Both pistons require a hole for the nickel rod to be attached. Five recesses are machined in each for the spring rings. The difference in design of the two is that the lower piston



is longer, and the gudgeon bosses for the connecting rod are part of the lower piston.

Previously the bottle neck hole was formed by a sand core, with, of course, a machining allowance. The piston was poured by a fountain gate from the bottom, which is probably the cleanest way to pour such a casting, but the combination of a thick section and the hottest iron was responsible for the porosity.

The treatment in this case is just a repetition of a casting, previously dealt with by the author; that is the sand core was replaced by an iron chill, slightly smaller than the sand core. This proved quite effective. When the chill was bored out the metal was quite sound and dense. Additionally, the piston could be poured from the top or bottom, the result in either case being just as satisfactory. The method of moulding is shown in sketch B, Fig. 6.

Analysis of Iron.

The foregoing notes would be incomplete without some reference to the grade, quality and analysis of the metal suitable for the castings outlined. What is known as the ordinary common grade of iron is not suitable. By this is meant that high-class castings of this nature cannot be poured with continuous success from any sort of iron. Hot, fluid, clean, dense iron is essential. This can be obtained both by expensive and inexpensive brands of iron, depending chiefly upon the mixing of the different grades and the selection of the scrap iron. The approximate analysis of metal suitable for any of these castings is:—Combined carbon, 0.60 to 0.80; graphitic carbon, 2.40 to 2.80; silicon, 1.00 to 2.00; phosphorus, 0.50 to 1.00; manganese, 0.50 to 0.80; and sulphur, 0.06 to 0.10 per cent.

Trade Talk.

MESSRS. HEDLEY MOORWOOD & COMPANY, LIMITED, of Foundrite Works, Pond Street, Sheffield, state their address is now 21, Church Street, as before.

THE LOCHGELLY IRON AND COAL COMPANY is understood to have concluded negotiations for a fusion of interests with Robert Forrester & Company, Limited, and the Plean Colliery Company. The last two mentioned are private companies.

MESSRS. TANKS & DRUMS, LIMITED, of Bowling Iron Works, Bradford, have purchased from the Sheet Metal & Galvanising Company, Limited, Lidger Green, Bradford, the goodwill and necessary plant for the making of pressed steel moulding boxes.

SOCIETE DU DJEBEL DJERISSA.—This Franco-North African concern reports shipments of iron ore from their mines in Tunis totalling 246,000 tons during the first half of 1923, compared with 198,000 tons in the corresponding half last year.

THE ASCERTAINED PRICE of West Coast hematite mixed numbers, upon which the iron-ore mines employés' wages for the ensuing month will be as based, is £5 11s. 5.36d. per ton, a decrease of 5s. 9.22d. as compared with the previous month's price (£5 17s. 2.58d. per ton); and, in consequence, iron mines employés' wages will be reduced by from 3d. to 6d. per day or shift, and boys by 1½d. per shift.

THE KEIGHLEY GEAR CUTTING COMPANY, of Fleece Mills, Keighley, have now moved to more commodious premises. This firm, who purchased the gear cutting business of Mr. Sam Sunderland in October, 1920, have recently completed the erection of an entirely new works, specially built and equipped for the economic production of accurately cut gearing for every purpose. The new address is Aireworth Works, Aireworth Road, Keighley, to which all communications should now be addressed.

MESSRS. SMITHS DOCK COMPANY, LIMITED, of the Tyne and the Tees, shiprepairers, have recently granted to Messrs. Swinney Bros., Ltd., ironfounders and engineers of the Wansbeck Iron Works, Morpeth, the license as sole authorised manufacturers of their oil-burning installations, and made over to them as a going concern, the whole of Smith's oil-burning installations department, this step having been taken in view of the extensions which Messrs. Smiths Dock Company are making at their North Shields repairing yards.

THE SOCIÉTÉ ANONYME JOHN COCKERILL, of Seraing, Belgium, have received an order from Messrs. the Staveley Coal and Iron Company, Limited, Barrow Hill, Chesterfield, for the supply of one twin tandem gas-engine direct coupled to a 5,000-kw. 3-phase alternator, 6,600 volts 30 cycles at 90 r.p.m. This engine will be operated by blast-furnace gas. The alternator will be supplied by the Ateliers de Constructions Electriques de Charleroi, of Charleroi, Belgium. This engine will be the largest gas-engine ever built, and will be a duplicate of two similar engines running in the Cockerill Company's own works in Belgium.

Paris Convention Notes.

We are informed that the following works are to be visited during the conference week:—Ateliers du Nord, steel castings manufacturers, etc., at Courneuve-Paris; Forges et Ateliers de Paris et la Seine, steel and iron castings manufacturers, at Noisy le Sec, Paris; Forges et Fonderies de l'Aviation, brass, bronze and aluminium founders, Gennevilliers, Paris; Usines de Vitry, steel founders, Vitry sur Seine, Paris; Bonvillain et Roncerary, iron founders, Choisy le Roi, Paris. For the banquet, to which ladies are invited, evening dress is optional. Visitors to Paris, who have passports, should see that they carry permission for visiting France.

Foundry Queries.

Chilled Plates.

We have an order for some 6 in. square cast-iron die plates ¾ in. thick which have to be chilled on the outside edges to a depth of ¼ in. We have tried several grades of iron, but have not been able to get more than 1-16 in. of chill. The metal must be soft enough to drill in the middle. The chills we are using are 2 in. square.

Will you kindly advise us as to the grade of iron to use, and if, in your opinion, our chills are thick enough? R. F. T.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

American Moulding Sand Researches.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—I have just noticed in your issue of July 12 a marginal note on page 25 with reference to the item entitled "Report on Sand Reclamation Investigation of the American Steel Foundries." The marginal note indicates that this is the report presented to the A.F.A. as referred to in my I.B.F. exchange paper.

On page 34 of the same issue there is a marginal note referring to section of my I.B.F. Paper which appeared in that issue and which states: "This report" (that of the Joint Committee on Moulding Sand Research presented at the 1923 A.F.A. Convention) "will be found in Vol. XXXI. to be subsequently issued of the 'Transactions of the American Foundrymen's Association,' and is printed elsewhere in this issue."

It appears that you understand the report on sand reclamation investigation of the American steel foundries to be the complete report of the Joint Committee on Moulding Sand Research presented at the 1923 A.F.A. Convention. This may have been due to a natural but incorrect interpretation of the term "American steel foundries." The sand reclamation report published on page 25 of your July 12 issue covers work done by a large corporation known as the American Steel Foundries, which is one of the many companies which have been actively co-operating with our Joint Committee. The point I want to make plain is that the report on sand reclamation published on page 25 of your July 12 issue is a contribution from one company, and does not represent an investigation of the steel foundries of America as a whole, nor does it by any means include all of the reports submitted at the A.F.A. Convention this year on sand reclamation. A great many pages were required to cover the entire report of the Joint Committee presented at the A.F.A. Convention last May. A portion of the report was of a general nature, while other portions related respectively to testing methods, to conservation and reclamation, and to geological surveys.

The work of the Joint Committee has been voluminous. One not familiar with the circumstances might judge otherwise from the references in your issue of July 12 to which I have called attention. It is expected that a pamphlet will be issued within a short time covering all of the reports made by the Joint Committee at the Cleveland Convention. I will take pleasure in forwarding you a copy of this report when it is published.

In closing, permit me to express our appreciation of the interest taken abroad in the work of our Joint Committee.—Yours, etc.,

R. A. BULL,
Chairman, Joint Committee on Moulding Sand Research,
American Foundrymen's Association.

Chicago,
August 6, 1923.

Obituary.

MR. JOHN HENRY CHESSHIRE, of West Bromwich, who was a well-known figure in commercial circles in the Midlands, died at Hagley this week. He was the founder of Izons & Company, Limited, cast-iron hollowware manufacturers.

British Standardised Steel Samples.—The standards as issued jointly by the Iron and Steel Institute and the National Physical Laboratory at present available are:—No. 1: Sulphur (S. = 0.027 per cent.). No. 2: Sulphur (S. = 0.071 per cent.). No. 3: Phosphorus (P. = 0.029 per cent.). No 5: Carbon (C. = 0.65 per cent.) acid open-hearth steel. No. 6: Carbon (C. = 0.10 per cent.) basic open-hearth steel. These samples are supplied, post free, at 21s. per bottle, containing 50 grammes, together with certificate of standardisation. Other samples are in preparation and will be issued when ready.

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—There are as yet no signs of a revival of activity in the Cleveland iron trade, which continues practically stagnant as regards buying and selling, nor can any change for the better be anticipated until at least September is well advanced, when it is to be hoped some improvement in the position may be reasonably expected. During the current week business is practically suspended, the markets being entirely closed in view of Stockton races, a popular local event which will engross the attention of the sport-loving public in the district. In the meantime the make of foundry iron is very limited, and with the output virtually in the hands of only one or two firms, prices are held more steadily than recently reported. Thus No. 3 G.M.B. remains at 102s. 6d., with No. 4 foundry 97s. 6d., and No. 4 forge 95s. No. 1 stands at 110s., but there is little demand for this quality, which, though scarce, could, no doubt, be shaded.

In the hematite section the closing down of no fewer than seven hematite furnaces on the North-East Coast since June 30, and the probability of others following at an early date, must undoubtedly influence the market position to some extent. Nevertheless, during the past week there has been a perceptible stiffening in the makers' attitude. The downward movement has, at all events, been checked, and the price of East Coast mixed numbers is well maintained at about 98s. to 98s. 6d. per ton. Twelve furnaces now remain in blast between Workington and Carnforth, with the output going largely to the Continent and to the Midlands. Bessemer mixed numbers are quoted at £5 10s. 6d. per ton, delivered at Glasgow and Sheffield, and £5 13s. per ton at Birmingham and South Wales ports

MANCHESTER.—Demand for pig-iron in this area has been largely curtailed of late by the prevailing slackness in the foundry trade, and the business now passing is usually confined to single truck loads to meet immediately pressing requirements. Small orders for No. 3 Derbyshire iron may perhaps be accepted at 95s. per ton on trucks, but for lots of 100 to 200 tons considerably lower offers would not now be refused.

THE MIDLANDS.—At Birmingham last week the market was only poorly attended, and smelters are finding it increasingly difficult to dispose of outputs. Midland consumers are not taking their normal quantities, even for these days of relatively small things. Sales of foundry iron, also, are rather disappointing. It is true that in individual cases rather more inquiry has been reported, but as yet this experience is general. Quotations: — Northamptonshire No. 3 foundry, 95s. to 97s. 6d.; Derbyshire No. 3 foundry, 97s. 6d., all net f.o.t. furnaces.

SCOTLAND.—Slightly increased activity in demand is reported in the Clydeside district, but the tonnages disposed of are still very small, and probably the slight augmentation is due to buyers, having run down their stocks, coming into the market for supplies to enable them to resume after the holiday. Prices continue to ease, and No. 3 is not over £5 5s. per ton at the furnaces, whilst for a substantial line some makers would accept close on £5. Unfortunately only small lots are being put through, and the process of reducing prices is making slow progress.

Finished Iron.

A shade more activity has been observable during the past week in some sections of the finished-material industry, but business on the whole has been of a holiday character, many of the mills and forges still remaining idle. Bar-iron makers report quiet times; that is, those who stand to the quotation of £12 10s. for crown bars. A few makers who bought heavily when materials were cheaper or have still Government stocks to resort to, are able to quote below this figure, and are picking up what little business is about.

Steel.

In the market for semi-products prices are somewhat easier, Siemens acid billets quoting to £12 10s., while soft basic billets can be bought at £8 5s. Other billet prices are quotably unaltered, and stand at £12 10s. for Bessemer acid, £10 5s. for hard basic and £10 for medium. Makers of finished steel are experiencing only a quiet demand, and the total volume of business that has passed has been insignificant. Some anxiety is expressed regarding the reported intention of the French Government to throw on the market large quantities of steel material seized in the Ruhr. The quantities mentioned, however, amounting to several hundred thousand tons, are believed to be greatly exaggerated; but in the present state of the world's demand for iron and steel a relatively moderate tonnage if offered without adequate safeguards would have a disturbing effect upon the markets.

Scrap.

There has been no improvement in conditions in the markets for scrap metal generally of late, and business on the whole may be reported extremely quiet. Labour trouble in the Scottish foundries has had, of course, an adverse effect upon the scrap trade in that area, with quotations a shade easier, heavy machinery cast-iron scrap running about 90s. per ton, and ordinary cast-iron scrap 80s.; light metal and furnace firebars 65s. per ton. Lancashire ironfounders are not yet tempted by the low prices for cast scrap to accumulate stocks at the works, and many of them are convinced that when pig-iron has at last reached a rock-bottom level scrap at present figures would not appear to be very cheap. Hence the sale of cast scrap is very much restricted, because it is bought for immediate use, and there is not much work now going on in the foundries. There is, in certain parts of the country, a small demand for "textile" scrap at about 85s. per ton, but this class of material used to compare in price rather with Scotch than with common pig-iron. Heavy steel melting scrap varies from about 60s. to about 70s. per ton, according to its position. Buyers seem very indifferent about it.

Metals.

Copper.—Inactive conditions have prevailed recently in the market for standard copper, and the tendency of values has been slightly downward, although fluctuations have been within a moderate range. The demand from consumers on either side of the Atlantic has been usually confined to actual near requirements, and, owing to the somewhat nervous state of the market and the absence of any sustained speculative support, American producers have been quite willing to shade their terms again in line with the market here. A fair amount of Continental interest is reported, this applying chiefly to France, Italy, and, to some extent, Germany. Domestic users carry only light stocks, but there has not been much falling off in their needs. Current quotations:—Cash: Thursday, £63 17s. 6d.; Friday, £63 10s.; Monday, £63 17s. 6d.; Tuesday, £64 5s.; Wednesday, £64 7s. 6d. *Three Months*: Thursday, £64 12s. 6d.; Friday, £64 7s. 6d.; Monday, £64 12s. 6d.; Tuesday, £65; Wednesday, £65 8s. 9d.

Tin.—Values of standard tin during the current week have maintained fairly steady levels, and markets on the whole may be reported rather more active, with better buying both on home and export account. Some covering purchases have been effected by home importers and also in the East, against sales made to America, which amounted to good quantities, at prices fully in line with London parity. Subsequently, some resales on the standard contract influenced some fluctuations from the best, but the tone at the finish was fairly confident. Sales in the East were comparatively light, and the prices realised out there were generally at above London parity, thus indicating that smelters were not very keen sellers. Current quotations:—Cash: Thursday, £184 12s. 6d.; Friday, £185; Monday, £186; Tuesday, £187; Wednesday, £190 7s. 6d. *Three Months*: Thursday, £186; Friday, £186; Monday, £187; Tuesday, £188; Wednesday, £191 7s. 6d.

Spelter.—Business in this metal of late has been the most active section of the market, with prices marking a consistently advancing tendency. A certain amount of interest has developed from the possibility of drawing on America for supplies. It appears that moderate quantities are available for export at the parity of £31 c.i.f. United Kingdom ports, but it is quite possible that such purchases will have the effect of stiffening the American market. Current quotations:—*Ordinary*: Thursday, £32 2s. 6d.; Friday, £32 15s.; Monday, £33 5s.; Tuesday, £33 7s. 6d.; Wednesday, £33 12s. 6d.

Lead.—The market for soft foreign pig has indicated an easier tendency of late, demand continuing on a moderate scale, while stocks at disposal are still amply sufficient for requirements. Substantial quantities of lead are still waiting in the river to be discharged, and it is difficult to escape the inference that had the dock strike not taken place the prompt quotation would not have held out as well as it has. Current quotations:—*Soft foreign (prompt)*: Thursday, £23 15s. 3d.; Friday, £24; Monday, £24; Tuesday, £24 2s. 6d.; Wednesday, £24 7s. 6d.

Company News.

Craven Brothers (Manchester), Limited.—Interim dividend of 5 per cent. on ordinary for half-year ended June 30.

Horseley Bridge and Engineering Company, Limited.—Profit, £21,888, compared with £36,730 last year; dividend, 4 per cent., tax free; carried forward, £8,247.

Swan, Hunter & Wigham Richardson, Limited.—Interim dividend of 3 per cent., less tax, on preference, and an interim dividend of 3 per cent., tax free, on ordinary, same as last year.

William Bayliss, Limited.—Net profit for the year ended June 30, £10,491, less debit balance brought forward; disposable, £8,944; dividend of 10 per cent., less tax; carried forward, £2,818.

Whessoe Foundry and Engineering Company, Limited.—Profit, £36,430, as against £55,268 in 1921-22; depreciation, £6,617, leaving a profit of £29,813; brought forward, £10,727; dividend, 10 per cent., and a bonus of 5 per cent., making 15 per cent., tax free, for the year; carried forward, £9,246.

Gazette.

W. HEBDEN, 2, Victoria Street, late Limmers Yard, St. Thomas's Road, Spalding, mechanical engineer, has been adjudicated bankrupt.

THE GRAISELEY ENGINEERING COMPANY, LIMITED, Wolverhampton, in course of liquidation. Mr. A. Francis, 53, Newton Street, Birmingham, has been appointed receiver.

IT HAS BEEN RESOLVED that the Dunston Engine Works Company, Limited, should go into voluntary liquidation. Mr. W. F. King, 31, Mosley Street, Newcastle-on-Tyne, C.A., has been appointed liquidator.

AT AN extraordinary meeting of the Reliance Iron & Steel (Llanelly), Limited, it was decided to wind up the company. Mr. C. Harold Griffiths, chartered accountant, of the firm of Griffiths & Miles, 46, Castle Bailey Street, Swansea, has been appointed liquidator.

German Foundrymen's President Arrested.—We understand that the President of the German Foundrymen's Association has been arrested by the French.

Personal.

COLONEL E. PINKNEY, manager of the ship-repairing department, and Major G. Denton, manager of the London office, have been appointed directors of Messrs. Swan, Hunter & Wigham-Richardson.

MR. J. A. S. RITSON has been appointed Professor of Mining in the University of Leeds, in succession to Professor Granville Poole, who has been elected to a professorship at Armstrong College, Newcastle-on-Tyne. Mr. Ritson was educated at Uppingham and at Durham University (Armstrong College), where he graduated with distinction in mining and surveying, and has had considerable practical experience of colliery management in various parts of the country. He acted for some time as personal assistant to Sir William Walker, late Chief Inspector of Mines, and is at present Senior Inspector of Mines in the Cardiff district. He also holds the appointment of Testing Officer for approving Rescue apparatus for use in mines.

Wills.

HILL, JOSEPH ALBERT, of Darley Dale, Derbyshire, engineer, ironfounder and steel manufacturer, of Messrs. J. & P. Hill, Sheffield £57,386

MATTHEWS, ROBERT, of Parrs House, Heaton Mersey, Lancashire, late a director of Sir Joseph Whitworth & Company £99,773

GREENOUGH, RICHARD, of The Dingle, Leigh, Lancs., brassfounder, and chairman of the Leigh Manufacturing Company, Limited £20,362

MUIRHEAD, WILLIAM, of North Mount, Vernon, iron and steel manufacturer, at one time chief metallurgist with Messrs. William Beardmore & Company, Parkhead £52,976

A Victim to Science.—A cricket match and a concert have been arranged to raise funds for the benefit of John Charlesworth, a moulder of Watery Lane, Sheffield, who lost his right hand when conducting a scientific experiment.

Telephone: 21, Penistone. Telegrams: "Durranns, Penistone."

ESTABLISHED 1863.

JAS. DURRANS & SONS., LTD.

Phoenix Works, Penistone NEAR SHEFFIELD.

BLACKING PLUMBAGO CORE GUM WHITE DUST COAL DUST

Manufacturers of

FOUNDRY EQUIPMENTS.

Ladles, Cupolas, Fire Bricks, Ganister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Write for illustrated catalogue on Blacking and Foundry Requisites, also for our latest Price List.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	64	7	6
Three months	65	8	9
Electrolytic	70	10	0
Tough	67	5	0
Best selected	67	5	0
Sheets	98	0	0
India	85	0	0
Wire bars	70	10	0
Do. September	70	5	0
Do. October	70	5	0
Ingot bars	70	5	0
H.C. wire rods	75	0	0
Off. aver., cash, July	65	6	10½
Do. 3 mths., July	66	0	6$\frac{5}{8}$
Do. Settlement, July	65	6	7$\frac{1}{8}$
Do. Electro, July	72	11	11$\frac{3}{4}$
Do. B.S., July	69	2	9$\frac{1}{8}$
Aver. spot price, copper, July	65	5	6$\frac{3}{4}$
Do. Electro, July	72	6	7

Solid drawn tubes 13½d.
Brazed tubes 13½d.
Wire 10⅜d.
Yellow metal rods 7¼d.
Do. 4x4 Squares 8⅜d.
Do. 4x3 Sheets 9¼d.

BRASS.

Solid drawn tubes 12d.
Brazed tubes 13½d.
Rods, drawn 10⅜d.
Rods, extruded or rolled 7¼d.
Sheets to 10 w.g. 10½d.
Wire 10¼d.
Rolled metal 10d.

TIN.

	£	s.	d.
Standard cash	190	7	6
Three months	191	7	6
English	191	10	0
Bars	192	10	0
Chinese	189	0	0
Straits	193	10	0
Australian	193	0	0
Eastern	191	0	0
Banca	193	0	0
Off. aver., cash, July	181	5	3$\frac{2}{2}$
Do. 3 mths., July	182	7	4$\frac{7}{11}$
Do. Sttlment, July	181	5	9$\frac{6}{11}$
Aver., spot, July	181	3	9

SPELTER.

	£	s.	d.
Ordinary	33	12	6
Remelted	30	0	0
Hard	27	5	0
Electro 99.9	36	17	6
English	33	15	0
India	29	5	0
Prime Western	33	15	0
Zinc dust	45	0	0
Zinc ashes	10	0	0
Off. aver., July	29	8	4$\frac{10}{11}$
Aver., spot, July	29	6	9$\frac{3}{4}$

LEAD.

	£	s.	d.
Soft foreign ppt	24	7	6
English	25	15	0
Off. average, July	23	19	10$\frac{7}{11}$
Average, spot, July	24	3	9

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	36	10	0
Do. V.M. ex whf.	36	10	0
Dutch	35	10	0
Rods	43	0	0
Boiler plates	35	0	0
Battery plates	35	10	0

ANTIMONY.

	£	s.	d.
English regulus	28	5	0
Special brands	34	10	0
Chinese	25	10	0
Crude	23	10	0

QUICKSILVER.

Quicksilver £9 0 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—
45/50% £12 5 0
75% £20 5 0
Ferro-vanadium—
35/40% 16/6 lb. va.
Ferro-molybdenum—
70/75% c. free 9/- lb.
Ferro-titanium—
2r3/25%, carbonless 1/2 lb.
Ferro-phosphorus, 20/23%, £28 10
Ferro-tungsten—
80/85%, carbon free 1/6 lb.
Tungsten metal powder—
98/99% 1/11 lb.
Ferro-chrome—
4/6% car. £21 12 6
6/8% car. £20 17 6
8/10% car. £20 7 6
Ferro-chrome—
Max. 2% car. £52 0
Max. 1% car. £62 0
Max. 0.70% car. £72 0
67/70%, carbonless 1/6 lb.
Nickel—99%, cubes or pellets £130 to £135
Cobalt metal—98/99% 11/- lb.
Aluminium 98/99% £115-£120
Metallic Chromium—
96/98% 4/3 lb.
Ferro-manganese (net)—
76/80%, loose £18
76/80%, packed £19
76/80%, export £18/10
Metallic manganese—
94/96%, carbonless 2/- lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten £ s. d. 2 6
Finished bars, 18% tungsten 3 0
Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Flats under 1 in. by ⅛ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness 3d. lb.
Bevels of approved sizes and sections 6d. lb.
If in coils 3d. lb.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces 3d.
Turnings and swarf 1d.
Per lb. net, d/d steel makers' works.

SCRAP.

South Wales—	£	s.	d.	£	s.	d.
Heavy steel	3	17	6	4	5	0
Bundled steel & shrngs.	3	10	0	3	17	6
Mixed iron & steel	3	12	6	3	15	0
Heavy cast iron	3	17	6	4	2	6
Good machinery for foundries	4	0	0	4	5	0

Cleveland—	£	s.	d.
Heavy steel	3	10	0
Steel turnings	3	5	0
Cast-iron borings	3	5	0
Heavy forge	4	5	0
Bushelled scrap	3	17	6
Cast-iron scrap	3	17	6

Lancashire—	£	s.	d.
Cast-iron scrap	4	0	0
Heavy wrought	3	17	6
Steel turnings	3	5	0

London — Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	56	0	0
Brass (clean)	36	0	0
Lead (less usual draft)	20	0	0
Tea lead	18	0	0
Zinc	19	0	0
New aluminium cuttings	75	0	0
Braziery copper	50	0	0
Gunmetal	47	0	0
Hollow pewter	150	0	0
Shaped black pewter	90	0	0

PIG-IRON.

N. E. Coast—	
Foundry No. 1	107/6
Foundry No. 3	102/6
Forge No. 4	95/-
Mottled	—
Hematite No. 1	99/6
Hematite M/Nos.	98/6
Midlands—	
Staffs. common*	103/6
„ No. 4 forge*	96/-
„ No. 3 foundry*	107/3
„ Cold blast, ord.	190/-
„ „ roll iron	200/-
„ basic	—
* d/d Birmingham district.	
Northants forge	85/-
„ fdry. No 3	95/-
„ basic	105/-
Derbyshire forge	87/6
„ fdry. No. 3	97/6
„ basic	105/-
Scotland—	
Foundry No. 1	109/- to 111/6
„ No. 3	104/-
Hematite M/Nos.	110/-
Sheffield (d/d district)—	
Derby forge	93/-
„ fdry No. 3	100/-
Lincs. forge	95/-
„ foundry No. 3	100/-
„ basic	105/-
E.C. hematite	110/-
W.C. hematite	112/6
All d/d in the district.	
Lancashire (d/d eq. Man.)	—
Derby forge	—
„ foundry No. 3	105/-
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
„ foundry No. 3	—
Dalzell, No. 3	121/6
Summerlee, No. 3	121/6
Glengarnock, No. 3	121/6
Gartaherrie, No. 3	121/6
Monkland, No. 3	121/6
Coltness, No. 3	121/6

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	11	10	0	12	10	0
Angles				12	5	0
Tees to 3 united ins.				13	0	0
Nut and bolt				10	15	0
Hoops				15	0	0
Marked bars (Staffs.)				14	10	0
Gas strip	12	10	0	12	15	0
Bolts and nuts, ⅜ in. × 4 in.				19	10	0

Steel—	£	s.	d.	£	s.	d.
Ship plates	£9	15	0	10	0	0
Boiler plates				13	0	0
Chequer plates				11	5	0
Angles	£9	10	0	9	15	0
Tees	£10	10	0	10	15	0
Channels				9	10	0
Joists	£9	10	0	9	15	0
Rounds & squares 3 in. to 5½ in.				10	0	0
Rounds under 3 in. to ⅜ in.				9	15	0
Flats, over 5 in. wide and up				10	5	0
Flats, 5 in. to 1½ in.				9	10	0
Rails, hvy	£8	10	0	9	10	0
Fishplates				13	0	0
Hoops (Staffs.)				12	0	0
Black sheets, 24 g.				13	0	0
Galv. cor. sheets, 24 g.				18	10	0
Galv. fencing wire, 8 g. plain				18	5	0
Rivets, ½ in. dia.				13	15	0
Billets, soft	£7/15/0			8	0	0
Billets, hard				10	0	0
Sheet bars	£8/10/0			8	15	0
Tin bars				9	2	6

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 2¾
Sheet	1 4
Wire	1 3½
Rods	1 2¾
Tubes	1 6¼
Castings	1 1¼

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.
Charles Clifford & Son, Limited, Birmingham.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/4 to 1/10
To 18 in. wide	1/4½ to 1/10½
To 21 in. wide	1/5½ to 1/11½
To 25 in. wide	1/6½ to 2/0½
Ingots for spoons and forks	9d. to 1/3
Ingots rolled to spoon size	1/- to 1/6
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	25.76
No. 2 foundry, Valley	24.00
No. 2 foundry, Birm.	24.00
Basic	26 27
Bessemer	28 26
Malleable	26 27
Grey forge	25.76
Ferro-manganese 80% delivered	117.15
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y, at mill	43.00
Bess. billets	42.50
O.-h. billets	42.50
O.-h. sheet bars	42.50
Wire rods	51.00
	Cents.
Iron bars, Phila.	2.67
Steel bars	2.40
Tank plates	2.50
Beams, etc.	2.50
Skelp, grooved steel	2.40
Skelp, sheared steel	2.40
Steel hoops	3.15
Sheets, black, No. 28	3.75
Sheets, galv., No. 28	5.00
Sheets, blue an'l'd, 9&10	3.00
Wire nails	3.00
Plain wire	2.75
Barbed wire, galv.	3.80
Tinplate, 100-lb. box	$5.50

COKE (at ovens).

Welsh foundry 40/- to 45/-
„ furnace 30/- to 35/-
Durham & North. fdy. 45/-
„ furnace 36/-
Other Districts, fndy 45/-
„ furnace 26/-

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes,	20×14, box	23/1½
„	28×20, „	47/2
„	20×10, „	33/9
„	18¾×14, „	24/1½
C.W.	20×14, „	21/4½
„	28×20, „	43/10½
„	20×10, „	29/3
„	18¾×14, „	21/1½
Terneplates	28×20, „	36/6